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# AIRCRAFT MANEUVERS FOR THE EVALUATION OF FLYING QUALITIES AND AGILITY

## VOL 3: SIMULATION DATA

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A set of aircraft maneuvers has been developed to augment evaluation maneuvers used currently by the flying qualities and flight test communities. These maneuvers extend evaluation to full aircraft dynamics throughout the aircraft flight envelope. As a result, a tie has been established between operational use and design parameters without losing control of the aircraft evaluation process.

Twenty maneuvers are described as an initial set to examine primarily high-angle-of-attack conditions. Perhaps as important as the maneuvers themselves is the method used to select them.

These maneuvers will allow direct measurement of flying qualities throughout the flight envelope instead of merely comparing parameters to specification values.

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## Foreword

As flight control systems become capable of providing a variety of aircraft response types and aircraft flight envelopes expand to include a wider range of angle of attack and speed, the ability to predict flying qualities becomes increasingly difficult. Traditional parameters, such as modal characteristics and time delay, cannot totally capture the relationship of aircraft dynamics, task performance and pilot workload. The success of the Handling Qualities During Tracking flight test technique led to the thought that a series of demonstration maneuvers could be defined for a variety of tasks which would augment the normal aircraft flying qualities description. In order to be useful, such maneuvers must be well-defined and suited to testing, must relate to the operational use of the vehicle and must be sensitive to parameters used in the design process.

The research documented in this four-volume report series has developed a process by which these maneuvers can be defined and validated as well as an initial set of maneuvers aimed primarily at agility and the *high-angle-of-attack flight regime*. A key word here is initial, limited resources did not allow this effort to address all aircraft types or missions. It is hoped that as various agencies and companies conduct their own research, they will develop additional or modified maneuvers and add them to this existing set. This process will allow the maneuvers to keep pace with the changes in aircraft technology and operational missions and tasks. New maneuvers should be sent to *WL/FIGC_2*, WPAFB OH, 45433-7531. An updated set of maneuvers and lessons learned will be available either by mail or electronically through the ARPANET computer network. For details, contact Tom Cord at (513) 255-8674. The resulting maneuver set will provide a basis from which demonstration maneuvers for the verification section of Mil-Std-1797B can be defined.

# Table of Contents

# Preface

This series of reports proposes aircraft maneuvers and general guidelines for the piloted evaluation of aircraft flying qualities and agility. These maneuvers augment rather than replace existing flying qualities evaluation techniques and are aimed primarily at expanded flight envelopes. A process to develop new evaluation maneuvers that link operational requirements to the design process is outlined and key concepts are identified. A format for documenting and selecting useful evaluation maneuvers is also described. Finally, the evaluation maneuvers and data demonstrating their sensitivity to design parameter variations are described.

This documentation is organized into a sequence of four reports. The first report, subtitled "Maneuver Development Process and Initial Maneuver Set," includes a detailed description of the research conducted as well as a summary of the results. It describes the maneuver development process used during this research and key considerations for developing new evaluation maneuvers. A brief summary of typical results observed for each maneuver tested is also included. The second report, subtitled "Maneuver Descriptions and Selection Guide," is a stand-alone document that describes the maneuvers tested during this research. It documents the intent of each maneuver, the aircraft attributes isolated, the techniques required to fly the maneuver, as well as presenting a cross reference to help select the most valuable maneuvers for aircraft evaluation. The second report is the beginning of a standard maneuver reference guide that will contain a wide variety of evaluation maneuvers for use throughout configuration development and flight test. It is recommended that new and existing evaluation maneuvers be added to this report to provide a source of evaluation maneuvers for the design and test community. The third report, subtitled "Simulation Data," consists of detailed information on the design parameter variations tested, subsequent statistical analyses conducted on the simulation data, and pilot comments and ratings from the testing. The fourth report, subtitled "Flight Test Plan," includes a preliminary test plan for the in-flight validation of the evaluation maneuvers.

# Acknowledgments

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## Data Summary

This report is a detailed summary of the data gathered during the Standard Evaluation Maneuver Set (STEMS) contract simulations. This is the third report of a four report sequence that documents the work conducted and results obtained during the STEMS research. The Preface of this document describes the relationship of these four reports. The other three reports can be found as References 1-3.

This report is composed of data appendices which further document the simulation effort, support the maneuvers described in Reference 2, and contain the simulation data set which is summarized in Reference 1. The first page of each appendix gives a short description and summary of the organization of that appendix. Appendix A includes pilot backgrounds for the pilots who participated in the simulations. Appendix B contains maneuver summary cards which document the overall pilot opinion of each maneuver. Appendix C describes the measures of merit that were considered during this research. It also includes specifications of the events used to establish the initial and final time for each maneuver (required for the calculation of the measures of merit). Appendix D contains the simulation data for the maneuvers tested under this research. It only contains data for the final version of each maneuver that was accepted as a STEM. For instance, if data was gathered for a maneuver during the first simulation and then the maneuver was modified and new data was taken during the second simulation, then only the final data is included in this report. Appendix D also contains additional descriptions of the statistical analyses conducted. Descriptions of the design parameters varied and the specific values tested as well as the measure of merit data and pilot comments for each maneuver are also included.

## References

1. Wilson, D.J., "Aircraft Maneuvers for the Evaluation of Flying Qualities and Agility - Maneuver Development Process and Initial Maneuver Set," WL-TR-93-3081, August 1993.

2. Wilson, D.J., "Aircraft Maneuvers for the Evaluation of Flying Qualities and Agility - Maneuver Descriptions and Selection Guide," WL-TR-93-3082, August 1993.

3. Wilson, D.J., "Aircraft Maneuvers for the Evaluation of Flying Qualities and Agility - Flight Test Plan," WL-TR-93-3084, August 1993.

# Appendix A
# Pilot Backgrounds

A total of nine pilots participated in this investigation, and their backgrounds are presented in this appendix. Throughout this report, the pilots are identified between their backgrounds, comments, and ratings as Pilots A, B, C, D, E, F, G, H, and I. A background sheet was not available for pilot D.

## Pilot Background Sheet for Pilot A

**Date:** 8 November 1991

| **Aircraft Flown** | **Hours** |
|---|---|
| F-18 Hornet | 1150 |
| A-7 Corsair | 250 |
| F-5 Freedom Fighter | 100 |
| F-4 Phantom | 50 |
| T-38 Talon | 50 |
| Plus 45 additional types | |
| **Total Hours** | **2100** |

| **Assignment** | **Years** |
|---|---|
| NATC Patuxent - Test Pilot | 3 |
| USAF Test Pilot School | 1 |
| CFB Bagotville, Canada - Fighter Pilot | 3 |
| Pilot Training - Tutors, CF-5, CF-18 | 3 |

| **Special Training** | **Year** |
|---|---|
| USAF Test Pilot School | 1988 |
| Master's Degree - Aviation Systems | 1991 |

| **Simulator Facility** | **Task** | **Year** |
|---|---|---|
| NASA Langley DMS | Pitch Control Margin | 1990-1991 |
| NATC Patuxent MFS | Departure Testing and many smaller tests | 1989-1991 |
| NAS Cecil Field OFT/WTT | Simulation fidelity evaluation | 1991 |

## Pilot Background Sheet for Pilot B

**Date:** 14 November 1991

| **Aircraft Flown** | **Hours** |
|---|---|
| F-16 | 1450 |
| F-4 | 500 |
| YF-22A | 23 |
| F-15, F-18, F-5, TAV-8B, F-111, and others | ≈0.5 each |
| **Total Hours** | **2500** |

| **Assignment** | **Years** |
|---|---|
| F-22 Program Office | 1 |
| YF-22 Flight Test | 2 |
| F-16 Flight Test | 2 |
| Test Pilot School | 1 |
| F-16 Operational | 5 |
| F-4 Operational | 2 |

| **Special Training** | **Year** |
|---|---|
| USAF test Pilot School | 1987 |
| F-16 Fighter Weapons School | 1984 |

| **Simulator Facility** | **Task** | **Year** |
|---|---|---|
| McDonnell Aircraft | ICAAS | 1991 |
| Lockheed | YF-22 | 1990 |
| General Dynamics | YF-22 | 1990 |

## Pilot Background Sheet for Pilot C

**Date:** 17 January 1990

| **Aircraft Flown** | **Hours** |
|---|---|
| F9-F / F-11F | 1500 |
| A4 / TA4 | 1200 |
| T34 / T28 | 120 |
| Decathalon | 250 |
| Pitts | 15 |
| **Total Hours** | **3500+** |

| **Assignment** | **Years** |
|---|---|
| VMT 203 Tactics Instructor | 1970 - 1971 |
| H&MS 11 Fast FAC/Intel | 1968 - 1969 |
| VT-24 Instructor / Tactics Instructor | 1965 - 1968 |
| 1st MAW Training Off. | 1964 - 1965 |
| VMA 533 Sqdn Pilot | 1961 - 1964 |

| **Special Training** | **Year** |
|---|---|
| Weapon Delivery School | 1962, 1963 |
| F.A.C. School | 1962 |

| **Simulator Facility** | **Task** | **Year** |
|---|---|---|
| NASA LaRC MBS | STOL Turbulence | 1974-1975 |
| MCAIR | Handling Qualities Studies | 1978-1990 |
| MCAIR | Flight Control Development | 1982-1987 |
| NASA LaRC DMS | High AOA Flying Qualities | 1983 |

## Pilot Background Sheet for Pilot E

**Date:** 8 November 1991

| **Aircraft Flown** | **Hours** |
|---|---|
| F-4 | 3000 |
| F-16 | 300 |
| A-4 | 250 |
| F-14 | 30 |
| T-2 | 200 |
| Civilian | 1200 |
| **Total Hours** | **5000** |

| **Assignment** | **Years** |
|---|---|
| USN Pilot Training | 2 |
| USN Operational | 3 |
| USN OT&E | 2 |
| USN Reserves | 9 |
| USAF Reserves | 5 |

| **Special Training** | **Year** |
|---|---|
| USN Pilot Training | 1970-72 |
| F-4/F-14 RAG | 1972/76 |
| USN Fighter Weapons School (TOPGUN) | 1976 |
| F-4/F-16 RTU | 1985/89 |
| USN Strike Leader Attack Training Syllabus | 1991 |

| **Simulator Facility** | **Task** | **Year** |
|---|---|---|
| Various USN | Pilot training/proficiency | 1970-1984 |
| Various USAF | Pilot training/proficiency | 1985-1989 |
| TAC ACES (Luke AFB) | Familiarization | 1984 |
| F-18 (Cold Lake) | Familiarization | 1988 |
| MCAIR | ICAAS/STEMS | 1991-1992 |
| Continental Airlines | Flight engineer training/proficiency | 1978-1983 |
| WL/Flight Dynamics Lab | Intelligent missile defense | 1989 |
| ASD | F-16 display investigations | 1990 |
| Armstrong Lab | FIT Lab | 1992 |

## Pilot Background Sheet for Pilot F

**Date:** 8 November 1991

| **Aircraft Flown** | **Hours** |
|---|---|
| F-4 | 300 |
| F-15 | 1200 |
| A-4 | 800 |
| **Total Hours** | |

| **Assignment** | **Years** |
|---|---|
| F-15 line pilot, Fighter Weapons School | 1975 - 1983 |
| A-4 Adversary, TOPGUN | 1984 - 1990 |
| AF-4 SEA | 1974 - 1975 |

| **Special Training** | **Year** |
|---|---|
| Fighter Weapons School, F-15 | 1978 |
| Instructor Fighter Weapons School | 1979 - 1983 |
| TOPGUN | 1988 |

| **Simulator Facility** | **Task** | **Year** |
|---|---|---|
| MCAIR | Training | 1975 |
| NASA | Thrust vectoring demonstration | 1984 |
| Luke AFB ACES | Simulation evaluation | 1985 |

## Pilot Background Sheet for Pilot G

**Date:** 7 May 1992

| **Aircraft Flown** | **Hours** |
|---|---|
| T-38 | 1200 |
| F-16 | 600 |
| A-37 | 300 |
| A-7 | 150 |
| Others, including: transport, helicopters, turboprop, gliders | |
| **Total Hours** | **2400** |

| **Assignment** | **Years** |
|---|---|
| VISTA Project Pilot | 1992 |
| USAF Test Pilot School Instructor | 1990 - 1991 |
| USNTPS Student | 1989 |
| F-16 Fighter Pilot | 1985 - 1988 |
| T-38 Instructor Pilot | 1982 - 1985 |
| Pilot Training | 1980 - 1981 |

| **Special Training** | **Year** |
|---|---|
| USN Test Pilot School | 1989 |

| **Simulator Facility** | **Task** | **Year** |
|---|---|---|
| Air Training Command | T-38 Motion-based Training of Students | 1980 - 1985 |
| F-16 Fixed-base | Emergency Procedures & Avionic | 1987 - 1988 |
| VISTA-F-16 at GD | Govt Confidence Testing (FQ & Avionics) | 1991 |
| MATV F-16 at GD | Thrust Vectoring Handling Qualities | 1992 |

## Pilot Background Sheet for Pilot II

**Date:** 10 December 1992

| **Aircraft Flown** | **Hours** |
|---|---|
| F/A-18 A/B/C/D | 850 |
| TA-45, F-15, F-16, M2000B, F-14D | 800 |
| **Total Hours** | **1900** |

| **Assignment** | **Years** |
|---|---|
| USN Test Pilot | |

| **Special Training** | **Year** |
|---|---|
| USAF Test Pilot School | 1992 |

| **Simulator Facility** | **Task** | **Year** |
|---|---|---|
| NAS Lemoore | Weapons Tactics Training (F/A-18) | 1988 - 1991 |
| NASA LaRC DMS | High AOA Lat/Dir Task Development | 1992 |

## Pilot Background Sheet for Pilot I

**Date:** 10 December 1992

| **Aircraft Flown** | **Hours** |
|---|---|
| T-38 | 1500 |
| C-5 A/B | 1600 |
| C-18 (707) | 150 |
| Other | 150 |
| **Total Hours** | **3400** |

| **Assignment** | **Years** |
|---|---|
| T-38 FAIP - Williams AFB | 1981 - 1985 |
| C-5 Pilot - Dover AFB | 1986 - 1990 |
| USAF TPS | 1990 - 1991 |
| Test Pilot (Wright-Patterson AFB) | 1991 - present |

| **Special Training** | **Year** |
|---|---|
| Masters Degree - Aero, Stanford | 1985 - 1986 |

| **Simulator Facility** | **Task** | **Year** |
|---|---|---|

# Appendix B
# Maneuver Summary Comment Cards

A maneuver summary card was used to capture the pilot's overall opinion of the maneuver immediately after evaluating all of the design parameter variations. This questions on this card were modified during the three simulations. The final version of the comment card is included in this appendix. Also, all of the second and third simulation pilot responses to the maneuver summary comment cards are included in this appendix. Responses are not included from the first simulation. The responses are listed in order of STEM number. If multiple versions of a STEM were tested, e.g. various pitch attitude captures, then they are indicated as "STEM 6 TEST 1", "STEM 6 TEST 2," etc. This specifics of each test are described in Appendix D.

| | |
|---|---|
| 1. How well does the maneuver represent the operational task element? | 5 4 3 2 1<br>Closely ☐☐☐☐☐ Remotely |
| 2. Is the maneuver well defined? Please describe any specific techniques used. | 5 4 3 2 1<br>Well Defined ☐☐☐☐☐ Poorly Defined |
| 3. Is the maneuver repeatable and easy to fly? | 5 4 3 2 1<br>Easy, Repeatable ☐☐☐☐☐ Difficult |
| 4. Did variations in design parameters result in observable differences in response? | 5 4 3 2 1<br>Very Significant ☐☐☐☐☐ Not Significantly Different |
| 5. Would entry/exit conditions be difficult to establish during flight test? | 5 4 3 2 1<br>Easy ☐☐☐☐☐ Impossible |
| 6. What information is required (e.g. airspeed, bank angle, target aircraft, etc.)? | 5 4 3 2 1<br>Conventional Information ☐☐☐☐☐ Highly Specialized Displays |
| 7. Additional comments: | |

**Final Version of Maneuver Summary Comment Card Used During Simulations**

## Pilot A Comments on STEM 1

Is the maneuver well defined? Yes, it's a little vague when I'm doing my repositioning one as to how often to do it. You could maybe set it up a little clearer by having it at a higher Ps state so I could pause and give an AOA using my own thrust like I'm doing here now between 15 and 20. You could tell the pilot to try recorrections about every 5 AOA up to 35 and then about every 10 after that try. So it's pretty well defined. I'll call that a 4.

Is the maneuver repeatable and easy to fly? Yes, I think it is. It's repeatable, it works out the same. It is fairly easy to fly and it's a nice indicator so that would be a 5.

Did variations in design parameters result in observable differences. Yes, definitely. When you're in guns tracking the objective is so clear and so immediate that you drive your gains immediately to what's required. And so that tends to conceal some of the changes in design parameters. It's so obvious what you want to do with the airplane that you're willing to make all of the compensation immediately. So it's a little harder to do a self analysis and see what compensation you're making but there were some definite observable differences in response across the spectrum. I would like to see a little more. It would have been nice to have an airplane that you couldn't track with because of sluggish response. Almost all the airplanes I saw were either good or too quick, but it wasn't bad. I'll call that a 3.

Would entry/exit conditions would be difficult to establish during flight test. I think that would be dead easy. That will be a 5.

What information is needed? You need a fixed gun sight with a circle around it that's of good enough size. It's nice to have the two circles like that. You could get a way with just one circle though. And otherwise you just need conventional information. Maybe slightly specialized. We'll call that a 4.

Additional comments. In order to develop this into Cooper-Harper we need to look at the data I've got and then look at the NASA agility simulation and pick off the requirements for desired and adequate handling criteria for tracking solutions and apply those to this. You could probably apply them directly.

## Pilot F Comments on STEM 1

How well does the maneuver represent an operational task? Closely

Is the maneuver well defined? I'd give it a 4. It's defined and it's easy to do from my point of view. I think that there needs to be some attention paid to the rate matching portion of the entry because every time that showed up a different pitch characteristics of the platform than did the normal tracking. So I think it's a good thing to have in the maneuver and I think we need to pay more attention to it. We've been looking at how well it handle as its angle of attack increases but what we're also looking at at that entry is how it handles when there's a rate mismatch.

Is the maneuver repeatable and easy to fly? It's easy to fly. The repeatability is, I'd give it a 4 only because you're going to have to very closely control the target parameters because if he changes descent rates, etc., you're going to have a different outcome. That's target sensitive, not necessarily fighter sensitive.

Did variations in design parameters result in different responses? Yes. I'd give it a 4 again. There were significant differences. However, I could lump the configurations into 2 big groups. The first group is sloppy tracking because I would make an input and get no response. The second group was sensitive. I would get an immediate response. In those two groups, I could discriminate to the magnitude of the error generated in both cases. If I took all those eight I could put them in four groups I guess. Either sloppy response, precise response and then large error or small error.

Would entry/exit conditions be difficult to establish during test flight? No. You could get behind the guy. Give it a 4. The problem is that you're going to have to control what the target does very precisely.

What information is required? You're going to need a target tracking index or reference for the fighter aircraft.

## Pilot E Comments on STEM 4 TEST 1

How well does the maneuver represent an operational task? I think the maneuver represents an operational task pretty well. Give that a 4 or 5.

Is the maneuver well defined, repeatable and easy to fly? Yes, how easy it is to fly depends on the configuration but I'd give that about a 4.

Did the variations in design parameters result in operationally significant differences? Yes, I would give that a 5. The dynamics turned it into a pitch capture or a lateral capture task. That made a lot of difference and also the maximum angle of attack seemed to make a lot of difference too because small angles of attack meant you had to drag the velocity vector around a lot. Large angles of attack typically turned the task into a lateral capture task so a lot of differences.

Would entry/exit conditions be difficult to establish during flight? Not particularly, about a 4 on that. Anytime you have 3 airplanes its going to be more difficult than with 1 or 2 but this one you should be able to set up fairly simply as we discussed. It would be easy if two of the airplanes, one of which is the test airplane, would have to have air-to-air TACAN or something like that. You could actually set this up visually probably without too much trouble because the distances are not great although it would be much easier with the radar.

What information is required? Basically all you need for the task is the pipper.

## Pilot G Comments on STEM 4 TEST 1

How well does this maneuver represent an operational task element? I think its pretty good. It is a good task to tie everything together. You do a lot of maneuvering, you have the two targets, quick heading changes. I'd give it a 5.

Is the maneuver well defined, repeatable and easy to fly? I think its very easy to fly. It is well defined, but we may want to tie in the pilot technique a little bit more as far as what you are and are not going to allow the pilot to do. If you want him to do a full loaded roll and if he's allowed to use rudder or not. I've been doing these with feet on the floor. But you need to decide whether you want to leave it totally up to the pilot or define it better as far as what you are going to allow him to do and that's going to affect your repeatability. So I'd give it a 4. It is easy to fly but it could be maybe a little bit better. We need to define what we are going to allow the pilot to do which is going to affect the repeatability

Did the variations in design parameters result in operationally significant differences? I'd say yes. We saw a lot of different configurations that if nothing else showed how I had to vary my pilot technique to optimize the aircraft's performance. Especially the first couple where we had such poor pitch pointing capability really highlighted things. So I'd say it was a 5. I think there were very significant differences in the configurations as far as either how you flew it or what the results were.

Would entry/exit conditions be difficult to establish during flight test? No, I think its pretty easy. We might want to talk a little more about the target orchestration and making that happen in flight test but I'll give it a 4 and as we played with it in the middle there it might be even possible to do the task back and forth, back and forth and not just make it one run because the geometry really isn't changing that much as we continue on in the task.

What information is required? I don't think you need anything, its pretty much conventional information. All you need is a reticle. I'd give it a 5. If you've got something to track with you are okay because you're not trying to hit an angle of attack, you're not trying to hit an airspeed, you're really not trying to do anything so a circle on the canopy would work. Other than that I think that the task has come a long way since yesterday and it seems to be very workable.

## Pilot G Comments on STEM 4 TEST 2

How well does this maneuver represent the operational task element? I will give it a five. It is a good maneuver when you have got more than one target to deal with out there.

Is the maneuver well defined? I give it a five now, I think it is very defined. My only hesitation on this is the definition of how many times you want to do this. And as I mentioned earlier, I am not a big fan of doing it more than once. I think you are starting to get too may variables going on and I am not sure what you are looking for. You know, the longer you do it, the less it is starting from a set known condition and so you are going to have more difficulty, I think, trying to compare airplanes or whatever you are trying to do. That is not to say it is not valuable, there is data to be had there, but it starts to get real vague.

Is the maneuver repeatable and easy to fly? Five. It is very easy to fly. It is very repeatable with this set up.

Did variations in design parameters result in observable differences? I will give it a four. With PST ON vs. OFF you could see a difference.

Would entry/exit conditions be difficult to establish? I think they would be very easy to establish. And really the range isn't that critical either. I mean, the only thing you have got to figure out is if you are at dead six o'clock.

What information is required? Really conventional information - five. The only addition, if you were real keen on range, you would have to have an air to air TACAN or radar, but it is not that important. Really, all you need is a pipper and air speed indicator and you can have at it.

Additional comments:
Overall, I think it is a very good maneuver. We talked about the fact that because you start at a dead six o'clock, then your ability to get to the first target and track it is going to affect the geometry to the second target. Another possible measure of merit is the angular difference between the two targets when you go from target one to target two. Because that is going to vary based on the airplane's ability to track and the airplane's ability to turn.

## Pilot A Comments on STEM 5

How well does the maneuver represent the operational task element? This is kind of a weak representation because the real big focus in this maneuver is holding a constant AOA. And if I was doing an actual roll over, I would be doing a seat of the pants, looking over my shoulder, the AOA would come up, and then once my roll rate slowed down or I got the nose around, then I would be unloading the airplane. Your longitudinal stick dynamics are significantly different than they would be if I was actually doing it. I'm going to call it a 2.

Is the maneuver well defined? It's reasonable well defined. I knew what I was doing and I could tell when I did it wrong and when I did it right. A 4. My specific techniques again:205 knots straight and level, went to full blower, rolled over to 80° to 90° of bank with the nose about 10 degrees high, loaded up to 38 AOA, waited for 160 knots. At 160 knots I put in full pure lateral stick and then holding full lateral stick, played the longitudinal stick slightly forward and slight aft to hold the AOA. As I hit 180° roll and then I was going full forward stick and just holding that until the AOA was down below 0. I think in real life you would hold it for a lot less time. You would probably hold the full forward stick only until your AOA broke basically down to 10° or until you started getting light in your seat.

Is the maneuver repeatable and easy to fly? It is hard to fly and the difficulty is making it repeatable. So I'm going to call it a 1. It's difficult. You can do it but it's difficult.

Did variations in design parameters result in observable differences in response? Yes, significantly. I saw some that gave an immediate alpha break and some that gave a very slow alpha break. I'll call it a 4.

Would entry/exit conditions be difficult to establish during flight test? Well, this is real similar to what we are doing in the Hornet right now. We set up a turn, we hold an angle of attack, we wait for the airspeed, and as soon as we get the airspeed we put in a full stick input and then in the Hornet we are playing longitudinal stick to hold an alpha range. So it's doable in the Hornet. In some airplanes these are going to be real tough. A HUD makes it very helpful. If I was looking at round dials trying to match all these things I'd have trouble. So I would say it is difficult but doable, so we'll call it a 3.

What information is required? You really need a nice clear instrument group showing you the standard information. I don't think you need much else. You need AOA, airspeed, and bank

angle. Bank angle you should be able to get from the horizon. So conventional information. But it's pretty nice to have it in a HUD, so I'd say 5.

Additional comments. This is a very difficult maneuver for the pilot to rate because he's so task saturated and it's basically an open loop maneuver. Everything is an entry condition up to the point of full forward stick and then it's an open loop maneuver. You're holding the stick in the full forward corner, and then you are doing nothing. So it's a very high gain setup leading to an open loop maneuver and the relief at getting to the position where it's open loop kind of overpowers any impassive evaluation of the aircraft response. I think you should hope to get out of this primarily is how close do we get to the flight control limits of the aircraft.

## Pilot F Comments on STEM 5

How well does this maneuver represent the operational task element? I'd give it a 2. Not very well. The reason is not because you don't maneuver like this, the reason is that having to peg to an angle of attack is not operationally relevant.

Is the maneuver well defined? I don't think so. I think it's poorly defined. I'm having a hard time in here, but it may be the fact that I am not use to looking at these parameters.

Is the maneuver repeatable and easy to fly? I don't think it's repeatable and it's not all that easy to fly properly like you would like it flown with 160 knots, a set angle of attack roll, and then a bunt underneath.

Did variations in design parameters result in observable differences? I could say yes and give it a 3, but you have so many events going on simultaneously that it's very hard to tell whether it's a pilot input or a flight control problem.

Would entry and exit conditions be difficult to establish during test flight? I would say yes, it would be hard, give it a 2.

What information is required? We definitely need angle of attack where you can read it heads out while you are trying to do all the other stuff that's going on. So basically I guess a conventional HUD would do it.

## Pilot A Comment on STEM 6 TEST 1

How well does the maneuver represent the operational task element? It is one little facet of a lot of maneuvers. It represents those well, but it is scenario dependent.

Is the maneuver well defined? It is well defined as far as the mechanics of it. However, the scenario is undefined. If you don't get an agreed upon scenario, you are going to get different opinions. The mechanics are well defined, a 5. But the scenario is not described, so that needs work.

Is the maneuver repeatable? Yes, there is nothing to it, a 5.

Did variations in design parameters result in observable differences? Yes, significant, a 5. We went from something horrible to something that was great.

Would entry/exit conditions be difficult to establish during flight test? Entry conditions would be dead simple. Exit conditions might be a problem. By the very design of the thing, you end up pointed at the sky with no airspeed. If you have any sort of F-16 type problems where you rate yourself through the pitch limiter and get into a deep stall, this is how you would do it. You could easily get into an AOA hangup. So you would want to do this with a spin shoot. It would be a 5 to establish entry conditions and a 2 for exit conditions.

What information is required? Just standard displays, a 5.

Additional comments:
The scenario I used was a quarter plane a I described. It should be considered with a roll off at the end of it.

**Pilot E Summary of STEM 6 TEST 1**

How well does maneuver represent operation task? Well, trying to raise the nose from an already high angle of attack happens but not too much. I'd give that about a 3.

Is the maneuver well defined? Yes, it's well defined.

Is it repeatable? Yes.

Is it easy to fly? Yes, it's easy to fly once you know what the level conditions are and as long as they're not stringent so I'd give it about 4 or 5 on each of those.

Did the variations in design parameters result in operationally significant differences? Yes, very significant. Give it a 5 there.

Would entry and exit conditions be difficult to establish? Setting it up is not real easy because you have to use the technique of matching angle of attack and pitch angle to stabilize the flight path since you don't have a velocity vector in the field of view. And then you have to manipulate the throttle for airspeed but once you had a set configuration, a set aircraft, those things would be fairly well known and it would be a pretty easy thing to set up. So I'd give it about a 4.

What information is required? Obviously, you need airspeed, you need bank angle, you need pitch angle and you need angle of attack, so conventional information. I will give it a 4 because you're not going to have angle of attack on every HUD.

**Pilot H Comments on STEM 7 TEST 5**

How well does the maneuver represent the operational task element? Closely. I've seen it many times. Just pitch the nose up and perform the acquisition so you can shoot somebody. So, that's a five.

Is the maneuver well defined? Yes. Very well defined. That's a big five.

Is the maneuver repeatable and easy to fly? Yes. Easy to fly--no problems. That's a five.

Did variations in the design parameters resulted in observable differences? Yes. Four. Significant differences.

Would entry and exit conditions be difficult to establish? No. You can set yourself up at a certain range from the target so that would probably be a four once you figured ou· nat it was.

What information is required? Nothing, except conventional and something to shoot him with. So, that's a five.

Additional comments:
It is a pretty good maneuver.

## Pilot A Comments on STEM 7 TEST 6

How well does the maneuver represents the operational task? Really well. There I am 15 nose low and I pull up to capture some target to a get a lock. It's very closely related. It's a 5.

Is it well defined? Very well defined. I'm looking at this list of all these things under setup. I mean we're talking pitch angle, load factor, I'm not sure load factor needs to be in there. I'm just in a 15 degree dive at 340 knots and I pull up. All that other stuff kind of falls out. If anything it's over defined.

My specific techniques again. From straight and level with the throttles at idle, I pushed over to 15 degrees nose low pitch attitude, waited till the velocity vector got down to about 15 degrees, then threw it into afterburner, accelerated in a 15 degree dive out to 340 knots, and then pulled. The amount of pull depended on the flying qualities. Then I captured the target within the circle. You could have captured a pitch later also. Having the red lights come on in the simulator helps, but you could do it just as easily with mental counting of the timing. So it was well defined. It was a 5.

Was it repeatable and easy to fly? Yes. It's very simple and straight forward. It's a 5.

Did variations in design parameters result in observable differences? They sure did. We went from a CHR 7 to a 3 or 4. And I think if we had a good handling airplane you would easily get ones and twos out of it as well, so yes, 5.

Would it be difficult to establish during flight test? It would be tough to set up the target to get the geometry just right. I think you'd be better off for this one, since we're at higher speeds, to just use the pitch ladder. It would be a little tough with a target. Just using the pitch ladder would be easy. It would be a 5. If we had a target out there, it would probably be a 3.

What information is required? Just standard HUD information. You could also do it on round dial information.

## Pilot A Summary of STEM 7 TEST 7

How well does the maneuver represent the operational task element? I think it does a good job. It's a simple straightforward maneuver, easy to explain, easy to setup and it's fairly common. You want to pull up to get a snapshot of somebody to get a boresight lock of somebody or to go to a very quick gunshot of someone who is above you in a vertical flight situation. That's a natural operational task and this maneuver is a good representative of that so I'd give it a 5.

Is the maneuver well defined? Yes, it's very clear. There are limited parameters. It is straightforward.

Specific techniques used? It's very quick to do in the simulator. In the aircraft it would also not be too bad. You just get the aircraft trimmed and then pull the nose up so of course you'd waste more time, but still it's fairly easy to get to. You have a moderate amount of attention to lateral controls. So, lateral control is an important, but very minor input. So it's well defined.

Is it repeatable and easy to fly? Yes. It's very simple and repeatable. I'm holding the initial conditions plus or minus one degree of pitch in alpha and a couple knots maybe. And then it is very clear. The horizontal bars on the pitch target capture really help and that works fine.

Did variations in design parameters result in observable differences? Yes, very observable differences. Now my Cooper-Harper ratings only varied from four to two. I never saw anything that gave me only adequate criteria. I thought I could always hit desired criteria. What I was expecting to see was an airplane that was so sluggish in pitch that I was going to have to drop down to adequate, but I didn't see one. So our variations did not give me as much difference as I would have liked, plus I would have liked an aircraft that I was incapable of meeting the desired tracking criteria. So I had a fairly small scope of responses. So there were observable differences, but not as much as I'd like to see so I'll rate that as a two.

Would entry/exit conditions be difficult to set up? I talked about that already. They are not impossible, not easy, somewhere in between. I'll call that a three.

What information is needed? Well you just need enough information to get repeatable entry conditions. Which in this case are airspeed, angle of attack and a pitch ladder and of course the altitude. But that's all you really need. If we actually have a target out there then having the

horizontal bars really helps to give you a vertical criteria without a left/right constraint. So that's a five or a four.

Additional comments? Regarding (pilot F's) comments about trim. Historically, airplanes don't fly at a high AOA. And so as you get higher and higher, the stick forces proportionally increase and the airplane is not trimmed. We would not want an airplane that flew that way at the heart of the envelope I don't think. And so if the heart of this airplane's envelope is going to be very high AOA, you might want to reconsider what you want to do with the flight control design as far as trim requirements go at high AOA. The Hornet fazes in at 22 or 23° AOA but you start getting AOA feedback to stick forces and you might want to put that in at a higher AOA or not at all. And that's something maybe to investigate further.

## Pilot E Summary of STEM 7 TEST 7

How well does it represent the operation task element? I would say very closely; 4 or a 5.

Is the maneuver well defined, repeatable, easy to fly? Yes, depending on the configuration it is easier or more difficult to fly, but typically it's not a difficult maneuver to get set up for.

Did the variations of design parameters result in observable differences? Yes, very significant.

Would entry/exit conditions be difficult to establish? No, it would be easy.

What information is required? Typical things that you'd have. What I was using is airspeed and angle of attack and pitch angle.

Comments on Technique:
I left the throttle at full mil. Because the release conditions on the simulator are in a decent, you immediately have to increase the angle of attack to level off, so I was just pulling the nose up immediately to roughly the pitch angle I knew would stabilize the flight path which is about 30 degrees. And during that pitch up the airspeed would increase at military power maybe 5 - 10 knots. And once set at 30 degrees I just hold that, the airspeed would bleed back down to 122, then I'd do whatever I was going to do with the stick to begin the maneuver.

## Pilot F Comments on STEM 7 TEST 7

I think this maneuver closely represents operational task element--no comments.

Is maneuver well defined? It is well defined, particularly by setting airspeed and pitch attitude as entry. The parameters are very easy to hit and like I said, that leads me to a 3.

Is it repeatable and easy to fly? Very easy, very repeatable.

Did variations in design parameters result in a considerable difference in response? The answer is very significant. The issue of trim needs to be resolved, because tactically if the trim allows you to control your aircraft better, it's going to be used and I believe the use of trim allows systems that were unsatisfactory in capture, seemed to be very satisfactory when using trim during the maneuver. But I'm going to caveat that by saying that in this particular maneuver, you're only transiting 20 degrees in pitch, so your start trim condition and your end trim conditions are very close. Those maneuvers that the start and end trim conditions are very far apart, trim may have little or nothing to do with the evaluation process.

Would entry action conditions be difficult to establish during test flight? The answer is no. Easy to establish.

What information is required? All you need to know is your pitch attitude and your airspeed, and you need to also have some kind of pitch reference for 50 degrees nose high. I believe having a target out there for this simple of a maneuver would be a waste of resources in a flight test situation. I think the time and energy to set a guy up 50 high when you've got pitch ladders to do that, seems to me to be a waste of resources for a simple maneuver like this.

## Pilot G Comments on STEM 7 TEST 7

How well does the maneuver represent the operational task? I think it's pretty much a 5 as far as it's a very applicable task. I was considering whether the low speed was really applicable but so many times that's where you're going to end up in the fight. You're trying to get your nose up to get somebody so I think it's a 5.

Is the maneuver well defined, repeatable and easy to fly? I was going to mention later, you may want to break that question up since it talks about so many different things. I would think easy to fly might fall out differently from well defined and repeatable. Well defined - I think there are still a few variables that need to be defined in terms of how you're going to set the throttle setting. There's a lot of options left open in the definition of the maneuver such as the desired versus adequate time for the Cooper Harper Rating. The technique - are we going to make him use full aft stick or maybe two hands or one hand on the stick are not necessarily things that you want to dictate but they're probably something that a test program will need to define to get repeatable data. Overall, I think it is well defined but there's a few areas that could be better defined so I'd kind of break this up. I'd say about a 4 for well defined. Repeatable. It's very repeatable. I'd give it a 5. And easy to fly - I think I'd give it a 5 also. It is a very easy to fly maneuver. There are others that are probably safety concerns from a airplane flying versus a simulator flying.

Did variations in design parameters result in significant differences. I would say it's between about a 3 and a 4 on that. We did see some differences but it seemed like so many of your variations didn't really change the airplane that much. A lot of my ratings were about in the same range. It seemed like over half of the variations were merely adjusting when you made your lead point. It wasn't as obvious of a change in how the airplane handled. But when it did make a significant difference, you know, there were times when it did in the later configurations where I said I really liked it. So I'll give it a four on that.

Would entry/exit conditions be difficult to establish during flight test? I'd say it's a 5. I think they're very easy to establish these conditions.

What information is required? In terms of displays I think conventional information is acceptable. I'd give it a four but the only reason I wouldn't say a 5 is I may be factoring the HUD into there. I think it would be more difficult to hit the parameters and to do everything as

well without a HUD. It's nice to have a HUD so you can have your pitch already set and cross the altitude quickly and begin your pull right when you hit the airspeed.

## Pilot G Comments on STEM 7 TEST 8

How well does maneuver represent operational task element? I think it's a 5 - very closely. I think pitch captures are very important.

Is the maneuver well defined? I think it is pretty well defined except when we get into different throttle positions. We discussed that. So I'll gave it a 5 on defined.

Any special techniques used? I'd say make it a freestyle maneuver and then you can kind of monitor how much stick the guy ends up using. Because I definitely had to vary my technique with the different configurations.

Is the maneuver repeatable and easy to fly? That's a 5.

Did the variation in design parameters result in observable differences? The ones that we saw today were 5. There were very significant differences, particularly in the one.

Would entry/exit conditions be difficult to establish during flight test? It wouldn't be a problem. I give it a 5; however, doing it repeatedly would be a lot more difficult than it is here in the simulator.

What information is required? I think to really do this well, you need a target aircraft. I would put probably a 3 because you'd have to have a target aircraft, and I think you really ought to have a radar as well. As a minimum, you're going to have to have air-to-air TACAN. A radar would be nice because then you can have use your target locator line to find out that the guy is exactly whatever pitch attitude you're looking for. Otherwise it'd be completed doing the geometry. We didn't test using the HUD and trying to do a pitch attitude capture off the HUD, although that's typically fairly difficult with a airplane that has a high pitch rate.

Additional comments:
It's a good task. And I think it's also good to get pilot comments on the acquisition versus the tracking capability of the airplane.

## Pilot I Comments on STEM 7 TEST 9

How does the maneuver represent the operational task element? I would say, I'll give it a 4. It does closely relate to some flying instrument captures like glide slope. I like using the HUD out there. The HUD has given me a much bigger target than what I realized. I think it's a much better maneuver with the HUD than it would be looking at the ADI. The small changes on the ADI wouldn't crank your gain up enough.

Is the maneuver well defined? I think we would have to put some definitions in there like I said. And to me I think I'd look for a constant pitch rate up to the reticle and then do the capture. Otherwise I think the pilot gets in there and slows down the rate too soon. But otherwise it is a five.

Is the maneuver repeatable and easy to fly? I think so with those caveats we just talked about. Five.

Did variations in design parameters result in observable differences? Yes they did. You did something to the pitch rate and it came out pretty good. Five.

Would entry/exit conditions be difficult to establish? No, not at all. I'll give it a 5, easy.

What information is required? Conventional information, so a 5.

Additional comments:
That might be a better task than we initially thought.

## Pilot G Comments on STEM 8

How well does the maneuver represent operational task element? I'll give it a 4. I don't know that it's exactly perfect because it's somewhat of an artificial set up but I think our end result is something that continues to pop up in the realm of high angle of attack tactics and leading to the helicopter gun attack.

Is the maneuver well defined? I think it's...I'll give it a 4 and the reason it's not a 5 is because I don't think we've quite nailed down how we want to handle the acquisition versus the tracking phase. We need to define that a little bit better. Whether it's really two tasks or is it one task. And what are the instructions as far as flying the maneuver.

Is the maneuver repeatable and easy to fly? I'd say 5. I think it's very repeatable and easy.

Did variations in design parameters result in observable differences in response? I'm going to say a 3. There were mild differences but it seems like all my ratings were fairly close. There wasn't that much difference. There was a difference but it's not eye-watering by any means.

Would entry/exit conditions be difficult to establish during flight test? I'll say 4. It's almost a 5. I think they are easy to get into. Like I say, you'd have to work on getting the guy right over the top of you and also I think having the target fly 6 g points over and over again is going to get a little tiring for him.

What information is required? Really you don't need anything but a reticle to track. The lights are obviously helpful to get the 2 second capture but I don't think there's anything else I'd put in my cross check at all other than the reticle. I could have cared less about airspeed or anything. So I guess it is a 5. Conventional information is all you need.

## Pilot H Comments on STEM 8

How well does the maneuver represent the operation task? I would say closely, five. I thought it was very operationally relevant. You are pulling a track behind the guy and continue to try to track him.

Is the maneuver well define? Yes, I think it is well defined. I will give that a four just because you will get some variation according to how hard you pull, how long you pull, and when you reverse.

Is the maneuver repeatable and easy to fly? Yes, give that a five.

Did the variation in design parameters result in observable differences? I will give that a four. I saw some significant differences in roll performance and pitch sensitivities.

How difficult would the entry/exit conditions be to establish? They wouldn't be real easy. With some work I think you could do it. Give it a three. It would just take some practice to get it squared away.

What information is required? Not a lot. You are going to need a circle on the HUD or windscreen to aim through. So, pretty much conventional displays, four.

## Pilot E Comments on STEM 9 TEST 2

How well does the maneuver represent operational tasks? I'd say very closely. I would give that a four or five.

Is the maneuver well defined and repeatable? Well, not really currently. We need to define the airspeed limits, altitude limits and angle of attack limits and that sort of thing. So as it stands probably about two or so on that, but it should be easy to correct.

Do variations in design parameters result in operationally significant differences? Yes, I could see significant differences in the first two and the last two. The first two seemed to have more angular reserve than the last two. The first two seemed to have higher pitch rates than the second two. Not real dramatic but they just kept going for longer anyway. Maybe a little higher rates. It was difficult for me to break out the first (longitudinal configuration 140) and second (longitudinal configuration 141) or the third (longitudinal configuration 142) from the fourth (longitudinal configuration 143) except in the initial angle of attack in the trim condition so I guess I would give that a 3 or a 4.

Would entry/exit conditions be difficult to establish in flight test? Depending on your altitude bands, and that sort of thing, angle of attack and airspeed are pretty easy but it's a little difficult with things changing that fast to keep altitude right on. As long as you've got a 2000 ft altitude band I wouldn't think that would be a problem. So I'd give that probably a 4.

What information is required? You need angle of attack, airspeed and altitude, and a pitch ladder. That's all I was using.

**Pilot G Summary Comments for STEM 9 TEST 2**

How well does this maneuver represent an operational task element? I would say 5. I think it's very close to what you might have to do with an airplane to pull the nose to an opponent.

Is the maneuver well defined, repeatable and easy to fly? Well defined - I think we eventually defined it well. The way it's written right now it's not very well defined. We need a better specified technique. It looks like the technique we ended up with was a constant power setting, constant angle of attack level turn to a target airspeed. Other techniques that might work - we could use a constant G deceleration to the pull or you could use a constant airspeed increasing G to a target G and then pull, making sure that you matched your AOA up but I think the way we ended up here v s very easy to fly and repeatable and made it well defined. I'll give it a four as far as repeatability and ease to fly. The only reason I won't give it a 5 is just due to altitude control, and I think probably the altitude is not as big a player as far as what altitude you begin with but you are concerned about not having a climb or descent. In which case you might end up pulling up versus pulling down which can change your results although I don't think it changes very much because we talking about such a short time span.

Did variations in design parameters result in operational differences? I'd say 4. I thought they were fairly significant. I was able to see some differences. Particularly the last one, it didn't look like the maneuver was of any great effect or would help you operationally because you had very little angular reserve left. With some of the others you get, not a lot of angular reserve, but you do get a quick acceleration which could be handy and I think the second one (longitudinal configuration 140) probably had the greatest heading change capability in minimum time so there were differences that were apparent.

Would entry/exit conditions be difficult to establish during flight test? No, I don't think so. I don't think they would be any harder than in a simulator. I think the hardest part was the altitude control.

What information is required? You're going to have to have angle of attack, airspeed, and altitude. The HUD makes it nice but even with this HUD I think you need to be even a little more specialized. I'd say probably a 2 here on your scale. You need the capability to cross check your altitude control which I think ideally would be done with a pitch ladder and the flight path marker.

General Comments:
Other than that, I thought it was good maneuver. It is simple to fly. I have flown this maneuver before in aircraft and the only thing we weren't sure about was whether to do just the straight pull back or to roll into 90 degrees and then pull. And what we did today was just pull straight back, and I think that is a more repeatable maneuver, and I didn't see any problems with doing it that way.

## Pilot A Comments on STEM 11 TEST 4

How well did the maneuver represent the operational task element? I think it did very closely, it is very typical. Call that a 5.

Is it well defined? Yes, it is very clear what you are doing. Having the target there makes it straightforward. It is a simple capture task. Rate that as a 5.

Specific techniques: Generally, I did what any fighter pilot would do. I loaded up the airplane slightly, rolled to get him on the lift vector, use the g capability of the airplane to pull and make it a 2-D problem instead of a 3-D problem.

Is it repeatable and easy to fly? Yes, it is a 5, you can do it again and again. You can vary the technique if you want, but by using this technique you get the same results each time. It is easy to fly.

Did variations in design parameters result in observable differences in response. Yes they did. We saw a good variety, 5.

Would entry/exit conditions be difficult to establish in flight test. That is the hard part. This would be tough to set up. It takes a lot of orchestration, it takes another asset. You have to get the geometry just right and it would be hard to make the call as to well to do the pull p because you would not want to compare 1.5 mile pullups with 0.9 mile pullups. Because your ratings could be dependent upon range. There are some safety concerns since you are going to go blasting by each other. It could be done. But as with any head-on target, it will take longer to set up. You would probably have to drive out to 12 miles or so. It would not be easy, but it would not be impossible. I would rate it a 3.

What information is required? Just standard, conventional information. It is a 5.

Additional comments:
If you have a twitchy airplane, the handling qualities are going to improve as you get closer to the performance limit. It decreases any PIO tendencies because the stick is near the aft stop. The airplane is doing all it can just to get me there, so it tends to mask the handling qualities. So if you want to expose the handling qualities, you don't want to get to minimum range. I also think this maneuver is a really nice blend of all three axes. You are rolling, pulling, and

making yaw and roll corrections to get to a tracking solution. You could eventually combine this with a track at the end and you could get a lot of things out of one maneuver. So even though it is a little hard to set up, it quite a useful maneuver.

## Pilot F Comments on STEM 11 TEST 4

How well does this maneuver represent the operational task element? Yes, it does clearly.

Is the maneuver well defined? I'm going to give it a 4 again simply because what I'm doing is well defined. Target positions may be a little bit difficult to deal with.

Is the maneuver repeatable and easy to fly? The answer to that is: repeatable a 3, easy to fly a 4. Give it a 3 1/2, overall. The problem again is I know what I'm trying to do from my platform, repeatability though is very much dependent on the target's start conditions which are going to affect the maneuver parameters or data.

Did variations in design parameters result in considerable difference in response? The answer is yes, definitely. I'd give it a 5.

Would entry/exit conditions be difficult to establish in flight test? I'd say, give it a 3. It wouldn't be impossible.

What information required? You got it all in the HUD. In this particular situation, as a standard conventional information, I'd give it a 5, if the HUD has angle of attack on it and most of them do.

## Pilot A Comments on STEM 11 TEST 5

How well does the maneuver represent an operational task element? Pretty good. A face to face pass with some lateral offset. A late pick up you're trying to pull up and get a lock to a AIM-9 or a lock to a gunshot in the face or something like that. That's pretty representative and in this particular maneuver you're in low energy state coming face to face somewhere in a one circle - probably where you've lost a guy visually for a while and now you're picking him up visually again so I think it's a pretty good representation. I think the way we have it set up represents a fairly common scenario. I'm going to call it a 5.

Is it well defined? Its reasonably well defined. The factors that are different in it I think are how are you going to determine exactly when to pull up real world. How are you going to determine what the min range is going to be so you know when to do your pull up. Its easy in the simulator to set him up. I suppose you could do it with air to air TACAN or something like that when you hit a certain range then start your pull.

Any specific techniques used? The rolling maneuver really looks like a pure yaw once you have the alpha loaded up in the airplane. So you need to anticipate that by pulling the nose what appears to be left of the target airplane. And then slice over to the right as the roll has the appearance of yaw and a track onto the target and normally the lateral acquisition is on a line between 8:00 and 2:00.

Is it well defined? Its pretty well defined. It's clear. I'm going to call it a 4.

Is it repeatable and easy to fly? Yes, in the simulator definitely it's repeatable and fairly easy to fly and there wasn't much variation from run to run so I'll give it a 5.

Did variations in design parameters result in significant differences? Yes, I had ratings running from a CHR 5 up to a 3 I think. I was surprised I didn't get a better airplane. I thought I would get an airplane I could just yank up and point but yeah there was pretty good variation. So I'll call that a 4.

Would entry/exit conditions be difficult to set up in flight test? I think this may be the weakness of this one. One, I'm not in a steady state condition. I'm at a low angle of attack and yet 122 knots so the only way I could get to that would be to be doing a level decel and unload I guess or during an acceleration. I think you should probably specify the angle of

attack you want to start at. And then your airplane configuration would determine how you were going to get that particular combination of airspeed, angle of attack, and pitch attitude so that it's repeatable starting each one. Also the exact downrange distance between me and the target is going to be very difficult to control as would lateral separation. So yeah I think this would be a tough one to get the flight test. So I'd rate it as a 2.

What information is required? Very little. I mean just my regular flight information and a circle of some sort which you can get on just about any modern airplane so I'll call it a 5.

## Pilot F Comments on STEM 11 TEST 5

How well does maneuver represent an operational task? It closely represents.

Is maneuver well-defined? I'd say it's a 4. The reason is because the discussion about target displacement and set up. The maneuver itself from your own ship platform is well defined. The problem is if you're going to do this with another vehicle out there, you have to define where he starts from. I know what I'm supposed to do, the question is can I do it with the maneuver. So I will give it a 4 on that scale of being well defined.

Is the maneuver repeatable? Again I'd give it a 4. It is not all that easy to fly depending on the flight control. I mean to fly it properly - where you roll, pull and capture. I had a lot of trouble doing that so I'd say its maybe a 3. As far as repeatability, I could repeat my error so I'd give it a 4 on repeatability. So maybe a 3-1/2 or 4 there.

Did variations in design parameter result in significant differences? The answer is yes. I think we have 2 kinds of errors generated by this maneuver. The first one is generic errors because of high angle of attack maneuvering about velocity vector, which is inherent in any maneuver. The second one is sensitivity due to the design of the roll control and yaw control and pitch control functions and they do cause a difference in ease to complete the maneuver. But I've seen the same errors in the maneuver but to varying degrees based on the design.

Would entry/exit conditions be difficult to establish during flight test? I would say I would give them a 3, not impossible but not all that easy either. The test vehicle has to see the target consistently and has to start the maneuver at the proper range consistently, as well as having the right displacement offset consistently is going to be difficult in flight test. Give it a 3.

What information is required? A standard flight control system is fine with a standard heads up display with angle of attack on the heads up display.

## Pilot F Comments on STEM 11 TEST 6

How well does the maneuver represent the operational task element? I'd give it a 5. It closely represents it.

Is the maneuver well defined? I'm going to give this a 3. The maneuver is well defined, but the target position is going to be difficult to establish consistently. Therefore the maneuver is going to change geometry significantly.

Is the maneuver repeatable and easy to fly? I'm going to give it a 2 on that simply because the target positioning is so critical to the outcome.

Did the variation in design parameters result in observable differences in response? I'd give it a 5 for very significant.

Would entry/exit condition be difficult to establish during flight test? I'd say 2 for very difficult.

What information is required? Give it a 5.

Additional Comments:
It's a good maneuver overall if you could just establish the target position. If you can't do that consistently, you're going to have data scatter. If he has a radar lock he'll have to draw with a slant range. But if he's doing it visually, you could have variation of a half mile start point, which is going to have a significant difference on the turning room available which is going to have a significant difference on end of completion as far as your time based measures merit.

## Pilot C Comments on STEM 12 TEST 1

Does this represent an operational task element? Not even close. You don't typically do something like that particularly with the second reversal. If you got on a guy and caught him just right, you might want to track him around that first one. But the reversal, you wouldn't do.

Is the maneuver repeatable and easy to fly? It depends on how good a section line you can get. Ideally you have a beach or a long straight highway, and by long I mean 10 to 20 miles, so you've got adequate visibility over the nose. If you had a long section line that you could pick up repeatedly, the task would be pretty easy to fly. Without that it's bloody difficult. So with the section line it's easy and repeatable, a 5. Without a section line it's almost impossible.

Did the variation in design parameters result.in.observable differences in response? Yes, significantly different.

Would entry and exit conditions be difficult to establish during flight test? No, they should be pretty easy to set that one up. That's pretty standard. It's 5.

What information is required? A long straight section line. So it's not a specialized display. It's conventional information but you do have a requirement for an out the window so let's say it's about a 3.

## Pilot G Comments on STEM 12 TEST 1

How well does the maneuver represent the operational task element? I would say in current fighter tactics I'd have to give that about a 1. It's not in our minds that fighters are meant to do that right now. Surely we do split-S maneuvers, but that is typically because the guy passes us and we want to do a split-S and we want to get him.

Is the maneuver well defined, repeatable, and easy to fly? I'd give that a 4. Actually its much easier than it sounds. Like I said, the only problem is alpha control. I can hold it ±5 degrees reasonably. If you want to get any tighter than that its going to become more difficult to fly.

Did variation in design problems result in operationally significant differences? Well there's an operational word again. We have no operational use. Its not operationally significant. However, if we ever figured out how to use this thing then I'd say I saw definite changes in rate capability. So I'd give it a 4 as far as there were significant changes that occurred due to the design parameters, but I'm not sure how operationally significant they were.

Would entry/exit conditions would be difficult to establish during flight test? From a pure maneuver standpoint, it was easy. I'd give it a 5. From a reality standpoint of airplanes, it's going to be very dependent on your airplane as far as what you can do. If you're flying a T-38, it ain't going to happen. You know some airplane like that is going to wing rock or you're concerned about departure or stuff like that. One thing is going to happen in flight test, you're going to burn a lot of fuel in climbing back up between maneuvers.

What information is required? You've got to have angle of attack available in the HUD. You need a HUD, for all of these are going to be easier with the HUD. But you've got to have the angle of attack up there which some airplanes don't have. So you're going to have to have probably a 2, somewhat highly specialized display.

Other comments:
It would probably be much easier to see your 180° changes in flight test because you'd have better ground references, but that also could disrupt your flight test as far as trying to fly over an undercast or something like that. Its going to be difficult to do the heading changes.

## Pilot C Comments on STEM 12 TEST 2

Does it look an operational element? Well, it's closer than the 180° heading change. If you're trying to do a reversal on a guy, a split-S a situation, a vertical scissors and you've misjudged which way he went, then as you're pulling through the inverted and you look up and you see he's off to my side, and you're going to keep the pull in, put some lateral stick in to come over to where your opponent is and then recommence the dogfight. So at least up to the point of the reversal that's a little closer to something that you might see in a vertical scissors. The reversal, probably not.

Is the maneuver well defined? Yes. It's pretty open looped but it's well defined. It's easy to conceptualize so it's up there in the well defined area so let's say a 4.

Is the maneuver repeatable and easy to fly? Yes. Now in this case you don't have quite the requirements for a section line that you had before. You need something out ahead of you so you can see where your initial heading is and then you need something off to the side, and that you can pick up because it's easy to go 90 degrees. The difficulty with that is, when you have completed your split-S, you need to be able to look out toward the horizon and pick up something. This is as you're coming through the vertical. You've got to look out ahead and see something ahead of you, and then you've got to look off to the right and pick out something off your wingtip and bank toward that and then as you go through that heading you've got to make the reversal and come back to the original section line. So then you need something. You wouldn't want to try this over the ocean or over the desert with no readily discernable terrain features that are 90 degrees apart. So in terms of being able to set this task up repeatedly, it's a little easier than the 180 degree task. So given you've got good visibility and you've got some section lines or something like that, it's a 5.

Did the variation in parameters result in observable differences? Yes, but probably not as vividly, at least on one of the configurations, as the 180 degree task where the roll rate continues to wrap up almost all the way out to the reversal point. So, we'll say a 4.

Would entry and exit conditions be easy to establish? 5.

What information is required? Not all airplanes are going to be able to display a 45 degree angle of attack. Most probes are limited to 30 so it depends. Now you've got a requirement to

display something that may not be available in a lot of airplanes and that applies to both tasks. So I won't say highly specialized, I'll say is is specialized. You need the angle of attack.

## Pilot H Comments on STEM 13

How well does maneuver represent the operation task element? The split-S is surely operational, but zooming around 360 degrees is probably not totally operationally relevant so I've got to give that one a 2. In high AOA maneuvering I could see some relevance.

Is the maneuver well defined? Yes, it's well defined. That's a 5.

Is the maneuver repeatable and easy to fly? Yes.

Did variation in design parameters results in observable differences? Yes. I was seeing sustained roll rates and response to stopping the roll rate so I'm going to give that a 4 for fairly significant.

Would entry and exit conditions be difficult to establish during flight test? That's a 5.

What information is required? Nothing really except AOA and those vertical capture bars so I would give that a 4. Conventional information basically with some vertical bars on there to help judge the capture.

Additional comments:
It was definitely easy to repeat. It's really easy to let the alpha decrease while you're trying to do the capture though. I can probably maintain alpha plus or minus 10 degrees.

## Pilot G Comments on STEM 15

How well does maneuver represent the operational task element? I would say five. There is a lot of times you want to get the nose back around real quick.

Is the maneuver well defined? I think it is a five, because it is well defined in the sense that it is not very well defined. It is a free style maneuver so you can do whatever you want. But, it is well defined as far as you need to end with your nose back up on the horizon with 180° heading change.

Is the maneuver repeatable and easy to fly? Yes, because it is free style, repeatability it is not a big player. I can see variabilities, what is the perfect slice back vs. not the perfect slice back.

Did variation in design parameters result in observable differences? We turned PST ON and PST OFF and there were very significant differences - five.

Would entry/exit conditions be difficult to establish during flight test? Five, it is very easy.

What information is required? Five - conventional information. It is a very straight forward easy task to fly.

## Pilot A Comments on STEM 16 TEST 2

How well does the maneuver represent the operational task element? It's just fine for that. The only problem with it is you need to come from a stabilized condition. In an ACM condition you're never at a stabilized condition so that's a little bit unrealistic. When you do it in flight test though it's so hard to get to that condition that your workload is representatively high. So in the simulator you have to really mentally get that scenario in your mind to get your gains and expectations up high enough. They become naturally much higher in real life. So I'll say it's a pretty good representation of a limited operational task. We'll call it a 4.

Is the maneuver well defined? Yes, it's very clear. I talked about the specific techniques. That's a 5.

Is it repeatable and easy to fly? Yes, in the simulator especially. Nothing to it. A 5.

Did the variations in design parameters result in significant differences? Yes that was really nice because the area that everyone is concerned about is the thresholds between 3, 4, 5 and 6 and we just saw all four of those things at four different variations. So they were very significant. So that was a 5.

Would entry and exit conditions be difficult to establish during flight test? Yes, it is a little bit tough in flight test to get these because you end up with lateral-directional problems. And it is very tough to solve all those problems and still get all your rates down to zero enough that you can get good data. So it is difficult but I know from experience that it's doable so we'll call it a 3.

What information is required? Really, all you need is standard HUD information. Nothing unusual. So that's a 5.

Additional comments: As I mentioned, I used the revised Pitch Recovery Rating scale from my own thesis and of course I'm happy with it but I think it's useful in the range that we were just looking at. For looking at level B to undesirable kind of characteristics, it seems to work pretty well and it's necessary to get that clear scenario in mind.

## Pilot F Comments on STEM 16 TEST 2

How well does the maneuver represent the operational task element? I'd give it a 4. Simply because people don't do a whole lot of unloads except in particular situations like a guns defense, where it's important. Very often it's not quite that length of an unload so it does represent an operational maneuver but not in the heart of operational maneuvers.

Is the maneuver well defined? Yes, it is. I think what we need to look at as a description of the maneuver entry is that it is very important to hit the entry parameters correctly so that you don't set up inertia into the initial condition. In other words you've got to be able to stabilize angle of attack and I think you need to look at the thrust of the airplane and pick some kind of pitch attitude to hit.

Is the maneuver repeatable and easy to fly? Yes, it is repeatable and yes, it's easy to fly.

Did the variations design parameters result in significant differences in response? I'm going to give it a 4. I could only tell a slight difference in onset rate between the first 3. When I got to the fourth one there was a significant difference in onset rate.

Would entry/exit conditions be difficult to establish during flight test? No. It would be easy to give it a 5.

What information is required? Conventional information.

## Pilot F Comments on STEM 17

How does the maneuver represent operational task element? I'd rate it as a 4 because I can see this entry to a lot of different maneuvers at the 90 degree point. So the entry to the J turn to the 90 degree point, either vertical, or heading, or maybe going 90 degrees nose low is probably pretty typical entry of a nose high entry.

Is the maneuver well defined, repeatable, and easy to fly? I'd give it a 4. And the only reason I don't give it a 5 is that the configuration changes affect the repeatability. The maneuver is less repeatable based on configurations. As an example that last one that I just flew would be difficult to repeat. The maneuver itself is easy to define. You put the stick in the full right hand corner, put the rudder in, and then you see what happens to the airplane. As far as repeatable though, and trying to control it and stop it at a heading. That's where either the rate of the pitch or the rate of the roll will affect the repeatability to maneuver. Especially that last one as an example, I used two or three difference techniques to try to bring my nose to a 180 degree heading change.

Did variation design parameters result in operationally significant differences? I'd say very significant, 5. It is evident by the difference in techniques and the difference in times to make the 180 degree turn and meet the 90 vertical.

Would entry/exit conditions be difficult to establish during flight test? I'd say it would be easy.

What information is required? My primary reference is the heads up display and I think you're going to probably need to set this up over some kind of outside reference, like a runway or so on because things are happening so fast in here. I have a pretty good idea of my pitch attitude but as far as a heading change, it's going by so fast I can hardly read it. So to do a complete 180 turn and understand what the timing hacks are you probably need some outside reference. So basically you need a HUD with some outside reference. So that would make it a more conventional information. Unless you want to put some queuing for a 180 degree turn. I'll just give that a 3.

Additional comments:
I think the most revealing part of the maneuver is going to be the initial pitch to a roll to meeting either 90 degrees of pitch down and maybe in some cases 90 degrees of heading change. After

that you tend to be dealing with the total pitch control of the aircraft when the controls are saturated in pitch.

## Pilot H Comments on STEM 17

How well does the maneuver represent the operational task element? The task was to get turned around and chase the guy that was going the other way. I would give it a about a 4 or so. The initial maneuvers that we did were fairly operationally relevant. Things happened more quickly in here than it did in the real world but the slice turn is definitely an option when you're trying to get somebody that's behind you. So I thought it was really representative on operational tasks. I'm going to give that a 4.

Is the maneuver well defined? It seemed to be well defined, repeatable, and easy to fly. I'd give that one a 5. It is very well defined because you're going against the stick stop so anybody can do that. Repeatable? I would think it would be because of the same reasons and the only difference in some of the maneuvers is that you're not getting to 90 degrees nose low. You're already through it. But that should still count. Easy to fly? Yeah, it is fairly easy to fly. It wasn't very disorienting.

Did variations in design parameters result in significant differences? I would give it a 4. Some of the ones I could tell that something was changed but I couldn't tell what. The last one with the big pitch capability already turned around before you knew it. It didn't even get the nose down 90 degrees so that was a big difference. You could definitely tell big differences in the way the aircraft was rolling about the velocity vector and how much nose down you would get before you pulled out.

Would entry/exit conditions be difficult to establish during flight test? Entry and exit conditions would be very easy to do in flight. Just as easy as doing a trim shot.

What information is required? I think conventional information is all you need to fly it. You really don't need anything on the HUD to tell you the truth. You should be able to look at the ground and figure about where 180 degrees was.

Additional comments:
I thought this was a pretty decent maneuver. It is fairly repeatable. And definitely easy to set up again and again and again.

## Pilot G Comments on STEM 18 TEST 1

How well does the maneuver represent the operational task element? I'd give it a 5. It's very close.

Is the maneuver well-defined? I would give it a 4. There may be a question as far as the tracking criteria that we want to use. I think there's probably more of a story to be told if you concentrate on really tightly tracking the pipper versus giving yourself that 30 mil leeway. If I really tried the real high gain, there's going to be problems. So my pilot technique was probably a little more open loop than some people may be.

The maneuver is repeatable, it's easy to fly. I'll give it a 5 but it is a fatiguing maneuver. It takes a lot of pilot concentration.

Did variations in design parameters result in observable differences in response? I'd say 4. They weren't always exactly obvious but there were some differences that we saw in the ones that we tested.

Would entry/exit conditions be difficult to establish during flight test? I'll give it a 5. On the one hand it's easy; on the other hand, well, but I'll hit that on the next question.

What information is required? I would give it a 4 although it may even be worse because you need a tanker and tankers are big bucks to use as a training aid. If there's any downfall to this thing, it would be the fact that you need a tanker to track.

Additional comments:
Closure is something to consider because the mil reticle has a great deal to do with how close you are in terms of trying to keep something inside that reticle, so range is critical. We definitely had a much greater success today than we did two days ago controlling our range, and this is probably closer to what the airplane would be like as well. So it was definitely doable for a single pilot, although I believe the option could exist to have somebody else control your throttles while you fly the task. Other variations would be to have somebody move the boom. Surprisingly I didn't get that much out of changing my aim point or trying to go to a wing tip or back down. I don't think I noticed that much. I was also surprised to find characteristics at a long range like the one where I felt it was very pitch sensitive when I was

further out but it didn't seem to affect the tracking that much once I got in. And that could have also been due to a more open loop flying technique.

## Pilot I Comments on STEM 18 TEST 2

How well does the maneuver represent the operational task? Give it a five. It does closely relate to it.

Is the maneuver well defined? I am going to give it a three. Because I think it is really highly dependent on how close you are to the boom. And that is going to have to be ironed out. There seems to be a world of difference based on range. So that needs to be better defined. Also, it is a little bit of a question in my mind if the rating is primarily based on the constant tracking or the repositions. And the repositions may throw in the need for some overshoot criteria like we would use for a gross acquisition.

Is the maneuver repeatable and easy to fly? It is not easy to fly in the sim because of the closure problem. That is the hardest thing I have in here is trying to make it repeatable so that I am judging the airplane only when we are at the 200 foot mark--plus or minus about 20. That has been really difficult - especially during the repositions. So I am going to give it a two, as far as difficulty.

Did variations in design parameters result observable differences? Yes, I think it is a good maneuver to bring out the design variations. So I will give it a five.

Would the entry/exit conditions be difficult to establish during flight test? No. I think it would be pretty easy to take that tanker and do this. So I will give it a five for easy. And it would probably be a lot easier in flight than it would be in sim.

What information is required? The target airplane. Otherwise just the conventional stuff, so it is going to be real easy for the tanker to get on some conditions. I am going to say a five.

## Pilot G Comments on STEM 19 TEST 1

How well did the maneuver represent the operational task element? I would give it a two because I think you are really extrapolating to make tracking an airplane in PA configuration like flying a final approach.

Was the maneuver repeatable and easy to fly? I would say a three. The biggest problem in the simulator is the speed control. That will tend to add to variability in a lot of ways. It is very well defined, but the repeatability and ease to fly are complicated by the speed problems. The speed control should be easier in the real airplane.

Did the variations in design parameters result in operationally significant differences? I would give it a one. I don't think they made much of a difference at all.

Would entry/exit conditions be difficult to establish in flight test? I'll give it a five. They would be very easy to establish in flight test. The only thing to keep in mind is the jet wash. You need to figure out ahead of time what depression angle to use to avoid the jet wash.

What information is required? All that you need is a pipper. If you have a dot, then you can do the task. Give it a five for conventional information.

**Pilot H Comments on STEM 19 TEST 1**

How well does the maneuver represent the operational task element? Probably remotely. I will rate that as a 2.

Are the measures of merit tactically relevant, operationally useful? Probably a 2. I can't really see where it is useful a whole lot.

Is the maneuver well defined, repeatable, easy to fly? I think it is well defined, fairly repeatable, and fairly easy to fly. There's a lot of dynamics involved. I wouldn't call it real easily repeatable. Probably only going to give that one a 3.

Did variation in design parameters result in significant differences? They resulted in some differences. They were kind of tough to isolate due to the nature of the beast there so I'm going to give that one a 3.

Would entry/exit conditions be difficult to establish? No, piece of cake. 5.

What information is required? Conventional. 5.

## Pilot 1 Comments on STEM 19 TEST 2

Does the maneuver represent an operational task element? I don't see it representing a operational task except for being built up to something like offset landings. So as a build-up task I think it may have some merit, but flying a heavy in the power approach against an airplane is not that ooerationally significant except as build-up, so I'll give it a 2.

Is the maneuver well defined? Yes it's well defined, so I'll give it a 5. The problem is that like we were talking about me flying the pendulum there on the roll ins and roll outs. It's difficult to isolate what's causing the pipper displacements.

Is the maneuver repeatable and easy to fly? Yeah I think so, so I'll give it a 4.

Did variations in design parameters result in observable differences? I would say that's the biggest weakness of the maneuver, so I'm going to give it a 1. I basically didn't see any differences except for that very last thing you gave me where we did get a lot more pipper errors.

Would entry/exit conditions be difficult to establish? No, I don't think so. I think they would be easy. You just have to tell the aircraft what to do and standard stuff for the lead aircraft, so a 5 on that also.

## Pilot A Comments on STEM 20

How well does the mission maneuver represent the operational task element? Pretty good. That's pretty reasonable for a precision approach break out. That's a little low for a TACAN break out. But on a precision approach you could easily break out this far over. Normally when you break out of these conditions, you have precipitation or wind or something, but otherwise it's good. So it represents an off alignment landing pretty well, so I'll give it a 4.

Is it well defined? Yes, pretty clear. We need to exactly specify what our touchdown requirements are as far as Cooper-Harper. Maybe you can get a feel looking at the data to quantify that. Right now all I'm really looking at is did I get close, what kind of gross errors did I have, and how hard was my workload and what was driving my workload.

Did I use any specific techniques? I was trying to get on centerline as quickly as possible while maintaining roughly the right glide slope, and then make a correction on glide slope to try and touch down at the right descend angle and on airspeed. If I was looking at them in order, it would be center line, then glide slope, and then airspeed, although I'm trying to do all at once.

Is it repeatable and easy to fly? The maneuver itself is very repeatable. It's not easy to fly, but it's not suppose to be. However, it's not an unnatural thing to fly. So it's a typical task. It's easy to conceive, but it's just that the flying sometimes gets hard to do. So we'll call it a 4.

Did variations in design parameters result in observable differences in response? Yes, I could see some big differences especially laterally. Longitudinally I felt one of them maybe had a small PIO tendency. That didn't seem to make a whole lot of difference. Thrust response I think makes a difference in airspeed control. So yes, pretty significant, about a 4.

Would this be difficult to establish during flight test? Not really. You could just set up a radar descent using some known object. You could survey your landing area, pick out reference features, and use those. You could use a taxiway or something like that so you get a consistent line up. Then you want to come through a certain window using those ground features of altitude and airspeed and then turn from there. We'll call it about a 4.

What information is required? Radar altitude would be nice rather than baro. An E bracket would make a lot more sense. With your peripheral vision you can get trend information as to AOA. If all you are focusing on is airspeed, then you have a big eye movement from the

velocity vector and outside up to the airspeed box, it's harder to pick up trends in a closed task like that. You need airspeed. You need angle of attack. You need the velocity vector. A HUD helps. Assuming a HUD and E bracket are conventional, that is a 4.

Additional comments: Some of the problems involved in landing precisely in the simulator are caused by the visuals. You don't get the peripheral cues, you don't get the depth perception of height sometimes, and also I don't have a natural feel for when my wheels are going to touch the ground. So sometimes, I was surprised because I thought I was going to make a perfect landing and then I touched down early, so that took some adjusting. The VASI is basically useless. It's not bright enough and you're too close in under these circumstances.

## Pilot F Comments on STEM 20

How well does the maneuver represent the operational task? I think the maneuver represents the operational task element very well, it is like breaking out of weather. I'd give it a 5.

Is the maneuver well defined? Yes, it's well defined for start conditions. I'd give it a 4 on that. As far as what we're trying to do in the inner part of the maneuver, I think I need to take a look at what's going on here in each segment of the maneuver. I think this maneuver has about three different segments. There is a segment where you do your first initial turn, and then you follow it very shortly there after by a second roll maneuver to get lined up, and then there is pitch and roll corrections to get down final. And of course one of the most important things is airspeed power control throughout all of this. So I think we need to take a look at defining each of those segments maybe a little bit better at what we're looking for, so I give it a 4.

Is the maneuver repeatable and easy to fly? I'd give it a 3. Maybe it's just the simulator, but the airspeed is really causing me a lot of problems in repeatability. And it's not that easy. It's a difficult maneuver to fly. I'd give it a 2.

Did the variation in design parameters result in observable differences in response? I'd say no, 3. I had plenty of roll and pitch to get over here. All my attention is centered on trying to keep my airspeed ±10 or 15 knots. So I really wasn't too sensitive to the roll and pitch changes.

Would entry and exit conditions be difficult to establish during flight test? I'd say no because you are going to land on the runway. It's not hard to establish a runway and an offset point that we want to do that. The only restriction would be safety of flight factors.

What information is required? I'd say just conventional information in the cockpit.

Additional comments: I don't know what to think about this particular maneuver in the power response that we've got here. I have not flown an airplane that had this kind of power problems. Maybe it's just me. Maybe I'm a little rusty, but it seems to me that whatever the variable was in the power response time causes a lot of problems in trying to land the aircraft. The biggest problem is rapid airspeed decay and lack of proper response followed by horrendous sink rate. The other problem is if you leave it up it tends to scoot on out.

# Appendix C
# Measure of Merit Descriptions

The quantitative data analysis was conducted by calculating time history measures of merit and evaluating the ability to use this information to modify a design. A measure of merit screening process was conducted for each maneuver to select the most appropriate measureands. First, the Review Team helped generate a list of potential measures of merit. This list included a wide assortment of potential measureands. A fairly long list of measures of merit could be evaluated because automated processes were used to help calculate the measures of merit from the time history data. The measures of merit were intentionally selected to be simple to calculate and therefore hopefully easier to measure in a flight test environment. They were also selected to be meaningful from both design and operational standpoints. Measures of merit that obviously were not applicable to a certain maneuver were not calculated for that maneuver, but any that seemed even remotely possible were investigated. The list of potential measures of merit and the methods used to calculate them were updated between the simulations based on Review Team comments.

This appendix includes a list of the measures of merit that were considered during this study. This list is meant to be representative of typical measures of merit and is not intended to an all-encompassing set. All of the measures of merit were calculated from simple time history signals that are readily available from a simulation model and most should be available from flight test. Many of the measures of merit depend upon the definition of an initial and a final time for the maneuver. Any activity before the initial time was considered part of the maneuver setup and was not used for data purposes. Then activity only up to the final time was used to calculate the measures of merit. A summary of the definitions of initial and final time for each maneuver are presented first in this appendix followed by descriptions of the measures of merit considered.

## Definition of Initial and Final Time for Measure of Merit Calculations

| STEM | | Initial and Final Time Definition |
|---|---|---|
| 1 | Initial | Pilot achieves a stabilized tracking position (initial maneuver transients over) |
| | Final | Aircraft runs out of control authority to maintain track on target |
| 2 | Initial | Pilot achieves a stabilized tracking position (initial maneuver transients over) |
| | Final | Aircraft runs out of control authority to maintain track on target (or pilot knocks it off) |
| 3 | Initial | Pilot initiates aggressive roll input to begin acquisition |
| | Final | Pilot achieves lateral capture of target for 2 seconds |
| 4 | Note: Since two targets are involved, the data was analyzed three ways: | |
| | Initial | Initiation of the simulation |
| | Final | Pilot achieves a capture of target #1 for 2 seconds |
| | Initial | Initiation of the simulation |
| | Final | Pilot achieves a capture of target #2 for 2 seconds |
| | Initial | Completion of capture of target #1 |
| | Final | Pilot achieves a capture of target #2 for 2 seconds |
| 5 | Initial | Pilot initiates an aggressive forward longitudinal stick input |
| | Final | Aircraft passes through 10° AOA |
| 6 | Initial | Pilot initiates an aggressive longitudinal stick input |
| | Final | Aircraft has reached maximum pitch attitude and pilot releases stick, or aircraft pulls through the vertical and passes down through $\theta=60°$ |
| 7 | Initial | Pilot initiates an aggressive longitudinal stick input |
| | Final | Pilot achieves a capture of desired pitch attitude for 1 second |
| 8 | Initial | Initiates of the simulation |
| | Final | Pilot achieves a capture of target aircraft for 2 seconds |
| 9 | Initial | Pilot initiates an aggressive longitudinal stick input. |
| | Final | Aircraft heading rate ($d\psi/dt$) drops below initial value. |
| 10 | Initial | Pilot initiates an aggressive longitudinal stick input |
| | Final | Pilot achieves a capture of desired pitch attitude for 1 second |
| 11 | Initial | Initiation of the simulation |
| | Final | Pilot achieves a capture of the target aircraft for 2 seconds |
| 12 | Initial | Pilot initiates an aggressive lateral stick input |
| | Final | Aircraft passes back through original heading |
| 13 | Initial | Pilot initiates an aggressive lateral stick input |
| | Final | Pilot achieves a lateral capture of the desired heading for 2 seconds |

| STEM | | Initial and Final Time Definition |
|---|---|---|
| 14 | Initial | Pilot initiates an aggressive longitudinal stick input |
| | Final | Aircraft pitch attitude returns to zero |
| 15 | Initial | Initiation of the simulation |
| | Final | Aircraft heading angle is changed by at least 180° and pitch attitude passes through zero (do not require wings level) |
| 16 | Initial | Pilot initiates an aggressive forward longitudinal stick input. |
| | Final | Aircraft passes through 10° AOA |
| 17 | Initial | Initiation of the simulation |
| | Final | Aircraft heading angle is changed by at least 180° and pitch attitude passes through zero (can terminate maneuver at earlier pitch attitudes if desired) |
| 18 | Initial | Pilot achieves desired pre-contact position |
| | Final | Range to probe exceeds desired limits or pilot knocks off task |
| 19 | Initial | Pilot achieves a stabilized tracking position |
| | Final | Pilot knocks off task |
| 20 | Initial | Initiation of the simulation |
| | Final | Weight on either main wheel |

## Definition of Measures of Merit Considered During STEMS Simulations

### TPXDEG, sec

This measure of merit represents the time required to pitch the aircraft through X degrees of pitch attitude change. It was suggested as an open-loop measure of pitch performance and is was not intended to indicate a capture of X degrees. During the first simulation data processing, several specific pitch angle changes where calculated such as TP15DEG, TP30DEG, and others. So, for a single maneuver, several time to pitch measures may have been calculated. This approach was changed for the second and third simulations. Before calculating the measures of merit from the second and third simulations, time history plots were compared to select an appropriate pitch attitude change to evaluate. As a result, only one time to pitch measure was calculated for each maneuver during the second and third simulations.

### CLMAX, nondimensional

This measure of merit indicates the maximum lift coefficient attained during the maneuver. It was initially suggested and calculated for the first simulation, but it was later ignored during the data analysis because the lift characteristics were not varied during this testing (except for a single maneuver). As a result, this metric only showed up strongly if the maximum AOA attained varied below maximum lift coefficient. However, this measure could be valuable if vehicle changes such as planform ,flaps, or lex designs were being considered.

### TCLMAX, sec

This measure of merit indicates the time required to reach the maximum lift coefficient. It is an open-loop measure and did not require a capture of the maximum lift coefficient. It tended to be meaningful even if the maximum lift coefficient did not vary between the configurations. It is an important measure of the time required to reach the maximum turn rate.

### QD0AVG, deg/sec$^2$

This measure of merit indicates the average initial pitch acceleration. During the first simulation, this measure was calculated as the pitch acceleration occurring immediately at the initial time. This was found to be highly dependent upon the pilot input and exhibited a lot of variability. During the second and third simulations, it was calculated by averaging the pitch acceleration over some small time span at the beginning of the maneuver. The length of time was chosen to correspond to the QDXSEC metric. This method was somewhat better, but it was still highly dependent upon the aggressiveness of the pilot.

**QDXSEC, deg/sec$^2$**

This measure of merit indicates the pitch acceleration X seconds after the initiation of the maneuver. This metric was intended to compare each configuration's ability to provide pitch acceleration at the beginning of the maneuver. The actual time selected to compare pitch accelerations varied from maneuver to maneuver. The time was selected by comparing example time histories for each configuration and selecting the time which might show differences. In general, the time was longer for the slower speed maneuvers and slower dynamics. The time selected tended to be on order of 0.25 to 0.5 sec.

**QDMAX, deg/sec$^2$**

This measure of merit indicates the maximum pitch acceleration attained throughout the maneuver. It was calculated for both open and closed-loop maneuvers. For open-loop maneuvers it was a measure of the overall pitch capability for open-loop inputs. For closed-loop maneuvers, it was used to indicate how much acceleration the pilot was able to use for a closed-loop task.

**TQDMAX, sec**

This measure of merit indicates the time from the initiation of the maneuver until the maximum pitch acceleration was attained. It was observed that this metric should be considered along with the QDMAX measure of merit because a configuration may not have as much pitch acceleration capability but may it may hit its maximum much sooner thereby trading off the two metrics. Other cases were observed were a configuration had a higher maximum pitch acceleration and achieved it earlier thereby compounding its strengths over another configuration.

**QMAX, deg/sec**

This measure of merit indicates the maximum pitch rate attained during the maneuver. It was calculated for both open and closed-loop tasks. For open-loop maneuvers it was a measure of the overall pitch capability for open-loop inputs. For closed-loop maneuvers, it was used to indicate how much pitch rate the pilot was able to use for a closed-loop task.

**TQMAX, sec**

This measure of merit indicates the time from the initiation of the maneuver until the maximum pitch rate is attained. It was observed that this metric should be considered along with the QMAX measure of merit because a configuration may not have as much pitch rate capability but may it may hit its maximum much sooner thereby trading off the two metrics. Other cases

were observed were a configuration had a higher maximum pitch rate and achieved it earlier thereby compounding its strengths over another configuration. It was observed that this metric should not be calculated for a closed-loop task because differences in pilot technique for closed-loop tasks greatly affect this metric.

**QXSEC, deg/sec**

This measure of merit indicates the pitch rate X seconds after the initiation of the maneuver. This metric was intended to compare each configuration's ability to provide pitch rate early in the maneuver. The actual time selected to compare pitch rates varied from maneuver to maneuver. The time was selected by comparing example time histories for each configuration and selecting the time which might show differences. In general, the time was longer for the slower speed maneuvers and slower dynamics. The time selected tended to be on order of 0.5 sec.

**AOADMX, deg/sec**

This measure of merit indicates the maximum angle of attack rate attained during the maneuver. It was calculated for both open and closed-loop tasks. For open-loop maneuvers it was a measure of the overall AOA rate capability for open-loop inputs. For closed-loop maneuvers, it was used to indicate how much AOA rate the pilot was able to use for a closed-loop task. This metric had very similar trends to the QMAX metric for low speed conditions.

**TAOADMX, sec**

This measure of merit indicates the time from the initiation of the maneuver until the maximum angle of attack rate is attained. It was observed that this metric should be considered along with the AOADMX measure of merit because a configuration may not have as much AOA rate capability but may it may hit its maximum much sooner thereby trading off the two metrics. Other cases were observed were a configuration had a higher maximum AOA rate and achieved it earlier thereby compounding its strengths over another configuration. It was observed that this metric should not be calculated for a closed-loop task because differences in pilot technique for closed-loop tasks greatly affect this metric. This metric had very similar trends to the TQMAX metric for low speed conditions.

**ADXSEC, deg/sec**

This measure of merit indicates the angle of attack rate X seconds after the initiation of the maneuver. This metric was intended to compare each configuration's ability to provide AOA rate early in the maneuver. The actual time selected to compare AOA rates varied from

maneuver to maneuver. The time was selected by comparing example time histories for each configuration and selecting the time which might show differences. In general, the time was longer for the slower speed maneuvers and slower dynamics. The time selected tended to be on order of 0.5 sec and was chosen the same as QXSEC. This metric had very similar trends to the QXSEC metric for low speed conditions.

### NZMAX, g

This measure of merit indicates the maximum normal load factor attained throughout the maneuver. This metric was not evaluated for the low speed flight conditions because of the relatively small load factors encountered.

### TNZMAX, sec

This measure of merit indicates the time from the initiation of the maneuver until the to maximum load factor is attained. This metric was not evaluated for the low speed flight conditions because of the relatively small load factors encountered. It was observed that this metric should be considered along with the NZMAX measure of merit because a configuration may not have as much load factor capability but may it may hit its maximum much sooner thereby trading off the two metrics. Other cases were observed were a configuration had a higher maximum load factor and achieved it earlier thereby compounding its strengths over another configuration.

### NZDMAX, g/sec

This measure of merit indicates the maximum normal load factor rate attained throughout the maneuver. This metric was not evaluated for the low speed flight conditions because of the relatively small load factors encountered.

### TNZDMX, sec

This measure of merit indicates the time from the initiation of the maneuver until the to maximum load factor rate is attained. This metric was not evaluated for the low speed flight conditions because of the relatively small load factors encountered. It was observed that this metric should be considered along with the NZDMAX measure of merit because a configuration may not have as much load factor rate capability but may it may hit its maximum much sooner thereby trading off the two metrics. Other cases were observed were a configuration had a higher maximum load factor rate and achieved it earlier thereby compounding its strengths over another configuration.

**THTMAX, deg**

This measure of merit indicates the maximum incremental pitch attitude attained during the maneuver. It was calculated relative to the pitch attitude at the initiation of the maneuver to attempt to reduce variability. It was used to indicate the absolute maximum pitch attitude for the J-Turn maneuver however. It was calculated differently for the J-Turn to be a better indicator of the trajectory that was achieved.

**TTHTMX, sec**

This measure of merit indicates the time from the initiation of the maneuver until the maximum pitch attitude is attained. It was observed that this metric tended to be a misleading measurand. One configuration may have reached nearly its peak attitude very rapidly and then slowly continue to increase. Another configuration might result in a quicker time to maximum pitch attitude because it reached a lower attitude quicker. The first configuration might have actually reached the second configuration's maximum pitch attitude faster but because it continued farther and resulted in a much longer time. As a result, the TPXDEG measure of merit is a much fairer comparison.

**AOAMX, deg**

This measure of merit indicates the maximum angle of attack attained during the maneuver.

**TAOAMX, sec**

This measure of merit indicates the time from the initiation of the maneuver until the maximum angle of attack is attained. It was observed that this metric tended to be a misleading measurand. One configuration may have reached nearly its maximum AOA very rapidly and then slowly continue to increase (high short period damping). Another configuration might result in a quicker time to maximum AOA because it reached a lower AOA quicker (lower maximum AOA capability and low damping). The first configuration might have actually reached the second configuration's maximum AOA faster but because it continued farther and resulted in a much longer time. As a result, the AOAXSEC measure of merit is a much fairer comparison.

**AOAXSEC, deg**

This measure of merit indicates the angle of attack X seconds after the initiation of the maneuver. This metric was intended to compare each configuration's ability to provide AOA early in the maneuver. The actual time selected to compare AOA varied from maneuver to maneuver. The time was selected by comparing example time histories for each configuration

and selecting the time which might show differences. In general, the time was longer for the slower speed maneuvers and slower dynamics. The time selected tended to be on order of 1.0 to 2.0 sec.

**DELAOA, deg**

This measure of merit indicates the change in AOA between the initial and final time of the maneuver. It was designed to measure much AOA changed between the start of maneuver and end of a capture.

**TAOA50, sec**

This measure of merit indicates the time from the initiation of the maneuver until 50° AOA is reached. It was primarily designed for an original J-Turn maneuver where the pilot first pitched to 50° AOA and then rolled. The final J-Turn maneuver was flown with a simultaneous pitch and roll input technique, so this measure of merit lost some of its original intent.

**TCAPTR, sec**

This measure of merit indicates the time from initiation of the maneuver until a successful capture was obtained. The specific capture criteria used depended upon the maneuver. The capture sometimes required only a single variable to be captured (e.g. pitch or roll only) and sometimes it required multiple parameters to be satisfied (e.g. target within circular reticle). The length of time required to remain inside the capture tolerance also varied from maneuver to maneuver. The length of capture was used to ensure that the target was stabilized inside the tolerance band. A longer capture time was used to emphasize more of the transition to tracking phase and a shorter time was used to isolate acquisition from tracking. The target had to be within the tolerance for the continuous length of time specified for a valid capture. The pilot was provided a HUD display that represented the desired capture bands. A graphical explanation of the capture criteria are shown in Figures C-1 and C-2.

**TCMPLT, sec**

This measure of merit indicates the time to complete the maneuver. It was calculated as the time between the initiation of the maneuver ended. The maneuver end conditions varied from maneuver to maneuver. The definition of final time for each maneuver tested is shown at the beginning of this appendix. A graphical explanation of the capture criteria are shown in Figures C-1 and C-2.

**TSETTL, sec**

This measure of merit indicates the time to settle during a capture task. This was measured as the time required to capture after the desired time history signal first entered the tolerance band. It was intended to be used as an indicator of the number of overshoots and difficulty of stabilizing a capture. If two signals were being captured, then the settle time began after each had entered the desired band (not necessarily simultaneously). The settle time equals zero if the target entered the band and did not exit before the capture time was met. Figures C-1 and C-2 graphically describes this measure of merit. After performing statistical calculations with this measure, it was realized that this metric would not be gaussian in nature; therefore, statistical analyses of this metric are questionable.

**DELH, ft**

This measure of merit indicates the change in altitude during a maneuver. It is reported positive for an altitude gain between the initial and final times.

**DELHDG, deg**

This measure of merit indicates the change in heading angle during a maneuver. It was always reported positive regardless of a right or left turn.

**TDHDG, sec**

This measure of merit indicates the time to reach the change in heading angle. In particular for the Pitch Rate Reserve maneuver, it indicates the time that the heading rate drops below the initial rate. For this maneuver it indicates the length of time to attain DELHDG.

**DELPHI, deg**

This measure of merit indicates the change in wind axis bank angle during the maneuver. It was used to determine how much stability axis bank angle change was required during a maneuver.

**PMAXACT, deg/sec**

This measure of merit indicates the maximum stability axis roll rate attained during maneuver. It was calculated for both open and closed-loop tasks. For open-loop maneuvers it was a measure of the overall roll rate capability for open-loop inputs. For closed-loop maneuvers, it was used to indicate how much roll rate the pilot was able to use for a closed-loop task.

**TPMAX, sec**

This measure of merit indicates the time from the initiation of the maneuver until the maximum stability axis roll rate was attained. It was observed that this metric should be considered along with the PMAXACT measure of merit because a configuration may not have as much roll rate capability but may it may hit its maximum much sooner thereby trading off the two metrics. Other cases were observed were a configuration had a higher maximum roll rate and achieved it earlier thereby compounding its strengths over another configuration.

**PDMAX, deg/sec$^2$**

This measure of merit indicates the maximum stability axis roll acceleration attained during maneuver. It was calculated for both open and closed-loop tasks. For open-loop maneuvers it was a measure of the overall roll acceleration capability for open-loop inputs. For closed-loop maneuvers, it was used to indicate how much roll acceleration the pilot was able to use for a closed-loop task.

**TPDMAX, sec**

This measure of merit indicates the time from the initiation of the maneuver until the maximum stability axis roll acceleration was attained. It was observed that this metric should be considered along with the PDMAX measure of merit because a configuration may not have as much roll acceleration capability but may it may hit its maximum much sooner thereby trading off the two metrics. Other cases were observed were a configuration had a higher maximum roll acceleration and achieved it earlier thereby compounding its strengths over another configuration.

**PDMAXN, deg/sec$^2$**

This measure of merit indicates the maximum stability axis roll acceleration attained after a lateral stick cross-check during the maneuver. It was also calculated for closed-loop tasks and those that required a lateral cross-check. For open-loop maneuvers it was a measure of the roll deceleration capability for open-loop inputs. For closed-loop maneuvers, it was used to indicate how much roll deceleration the pilot used for a closed-loop task. It was always reported negative.

**PHIOVR, deg**

This measure of merit indicates the wind axis bank angle overshoot. It is a measure of the time and amount of bank angle required to reverse the direction of a stability axis roll. It was

calculated as the integral of stability axis roll rate for maneuvers in which the velocity vector was near vertical to avoid the singularity in bank angle.

**PS, ft/sec**

This measure of merit indicates the specific excess power at the end of a maneuver. It was used to indicate the final energy state of the maneuver. Design parameters that directly affect $P_S$ were generally not tested, but this measure can be used as secondary information to better understand the tradeoffs of increased agility.

**ENERGY, ft**

This measure of merit indicates the change in specific energy between the initiation of a maneuver and the final time. It was reported positive for a gain in energy and negative for a loss in energy. Design parameters that directly affect the total energy were generally not tested, but this measure can be used as secondary information to better understand the tradeoffs of increased agility.

**VDOTMX, kt/sec**

This measure of merit indicates the maximum rate of change in equivalent airspeed during a maneuver. It is a measurement of the peak linear acceleration during maneuver. Design parameters that directly affect the total energy were generally not tested, but this measure can be used as secondary information to better understand the tradeoffs of increased agility.

**DELV, kt**

This measure of merit indicates the change in equivalent airspeed between the initiation of a maneuver and the final time. It was reported positively for an increase in airspeed during the maneuver and negatively for a decrease. Design parameters that directly affect the total energy were generally not tested, but this measure can be used as secondary information to better understand the tradeoffs of increased agility.

**GAMDOT, deg/sec**

This measure of merit indicates the maximum flight path rate attained during the maneuver. It is an indicator of the ability to quickly move the flight path. This measure of merit was only calculated for medium to high speed maneuvers because flight path change was not considered the main objective for the low speed maneuvers. If other design parameters had been varied for the low speed conditions, this metric might have been more important.

### TGAMD, sec

This measure of merit indicates the time from the initiation of the maneuver until the maximum flight path rate was attained. This measure of merit was only calculated for medium to high speed maneuvers because flight path change was not considered the main objective for the low speed maneuvers. If other design parameters had been varied for the low speed conditions, this metric might have been more important.

### LONRMS, in

This measure of merit indicates the root mean square of longitudinal stick position. It was calculated to try to measure pilot workload and/or stick activity during a closed loop task. For tracking tasks, it was measured during the entire task. During acquisition tasks, it was measured only while the target was in the capture band so that the calculations related only to the capture and not the initiation of the acquisition. This metric generally showed a correlation to stick amplitude but not really to the frequency of inputs required to track the target. As a result, it tended to correlate to stick sensitivity, but not to the aircraft dynamics.

### LATRMS, in

This measure of merit indicates the root mean square of lateral stick position. It was calculated to try to measure pilot workload and/or stick activity during a closed loop task. For tracking tasks, it was measured during the entire task. During acquisition tasks, it was measured only while the target was in the capture band so that the calculations related only to the capture and not the initiation of the acquisition. This metric generally showed a correlation to stick amplitude but not really to the frequency of inputs required to track the target. As a result, it tended to correlate to stick sensitivity, but not to the aircraft dynamics.

### ELEVRMS, deg

This measure of merit indicates the root mean square of the elevation angle to the target. It was calculated to try to measure tracking errors during a closed loop task. For tracking tasks, it was measured during the entire task. During acquisition tasks, it was measured only while the target was in the capture band so that the calculations related only to the capture and not the initiation of the acquisition. This metric generally was not very successful.

### AZIMRMS, deg

This measure of merit indicates the root mean square of the azimuth angle to the target. It was calculated to try to measure tracking errors during a closed loop task. For tracking tasks, it was measured during the entire task. During acquisition tasks, it was measured only while the

target was in the capture band so that the calculations related only to the capture and not the initiation of the acquisition. This metric generally was not very successful.

**LONDEV, ft**

This measure of merit indicates the longitudinal position deviation upon touchdown for the Offset Approach to Landing maneuver. It did not result in successful correlations for this testing. However, as described in Volume I, the Offset Approach to Landing maneuver was dominated by a speed control problem. Also it is believed that this metric would require a lot larger number of samples than gathered during these simulations to be statistically significant. Therefore, this measure of merit should be investigated more.

**LATDEV, ft**

This measure of merit indicates the lateral position deviation upon touchdown for the Offset Approach to Landing maneuver. It did not result in successful correlations for this testing. However, as described in Volume I, the Offset Approach to Landing maneuver was dominated by a speed control problem. Also it is believed that this metric would require a lot larger number of samples than gathered during these simulations to be statistically significant. Therefore, this measure of merit should be investigated more.

**TDV, kt**

This measure of merit indicates the deviation from desired touchdown speed upon touchdown for the Offset Approach to Landing maneuver. It did not result in successful correlations for this testing. However, as described in Volume I, the Offset Approach to Landing maneuver was dominated by a speed control problem. Also it is believed that this metric would require a lot larger number of samples than gathered during these simulations to be statistically significant. Therefore, this measure of merit should be investigated more.

**GAMRMS, deg**

This measure of merit indicates the root mean square of the flight path angle error during the Offset Approach to Landing maneuver. It was calculated to try to measure the glide slope error during the offset correction. It did not result in successful correlations for this testing. However, as described in Volume I, the Offset Approach to Landing maneuver was dominated by a speed control problem. Also it is believed that this metric would require a lot larger number of samples than gathered during these simulations to be statistically significant. Therefore, this measure of merit should be investigated more.

**PXSEC, deg/sec**

This measure of merit indicates the stability axis roll rate X seconds after the initiation of the maneuver. This metric was intended to compare each configuration's ability to provide roll rate early in the maneuver. The actual time selected to compare roll rates varied from maneuver to maneuver. The time was selected by comparing example time histories for each configuration and selecting the time which might show differences. The time selected tended to be on order of 1.0 to 2.0 sec.

**PDXSEC, deg/sec$^2$**

This measure of merit indicates the stability axis roll acceleration X seconds after the initiation of the maneuver. This metric was intended to compare each configuration's ability to provide roll acceleration early in the maneuver. The actual time selected to compare roll accelerations varied from maneuver to maneuver. The time was selected by comparing example time histories for each configuration and selecting the time which might show differences. The time selected tended to be on order of 0.5 sec.

**CHR, nondimensional**

This measure of merit indicates the Cooper-Harper Rating received from the pilot. Cooper-Harper Ratings were only taken for closed-loop flying qualities tasks and were only given by pilots who had training in the use of the Cooper-Harper rating scale. Only simple statistics were applied (essentially only averages) due to limited data available.

**PRR, nondimensional**

This measure of merit indicates the Pitch Recovery Rating received from the pilot. Pitch Recovery Ratings were only taken for the 1-g Stabilized Pushover maneuver and were only given by the pilot who had training in its use. Only simple statistics were applied (essentially only averages) due to limited data available.

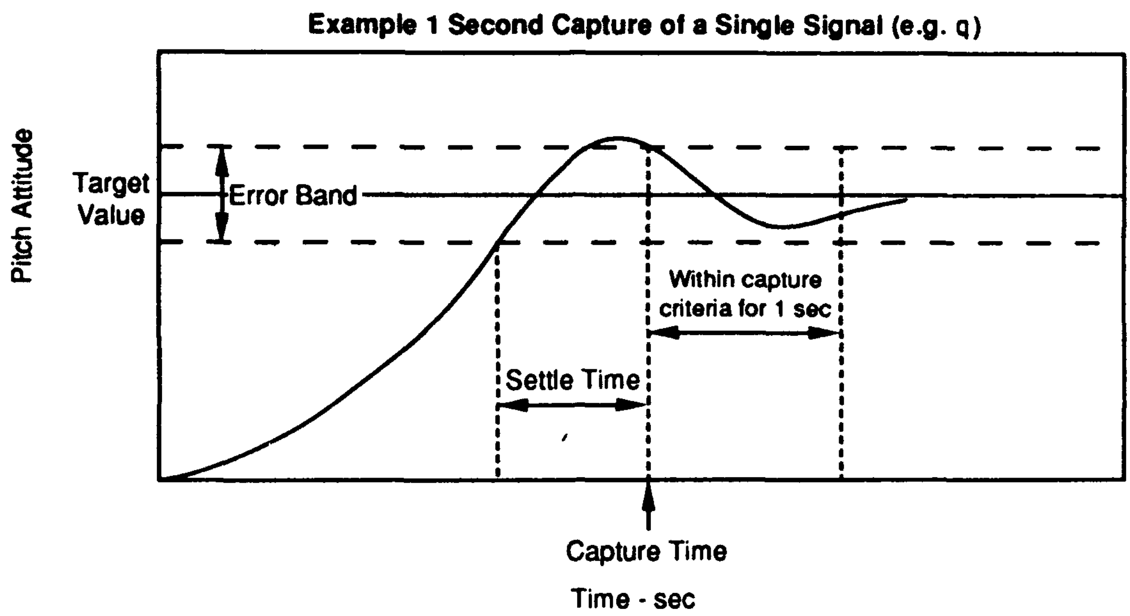



**Figure C-1. Definition of Capture Time and Settle Time for Single-Axis Task**

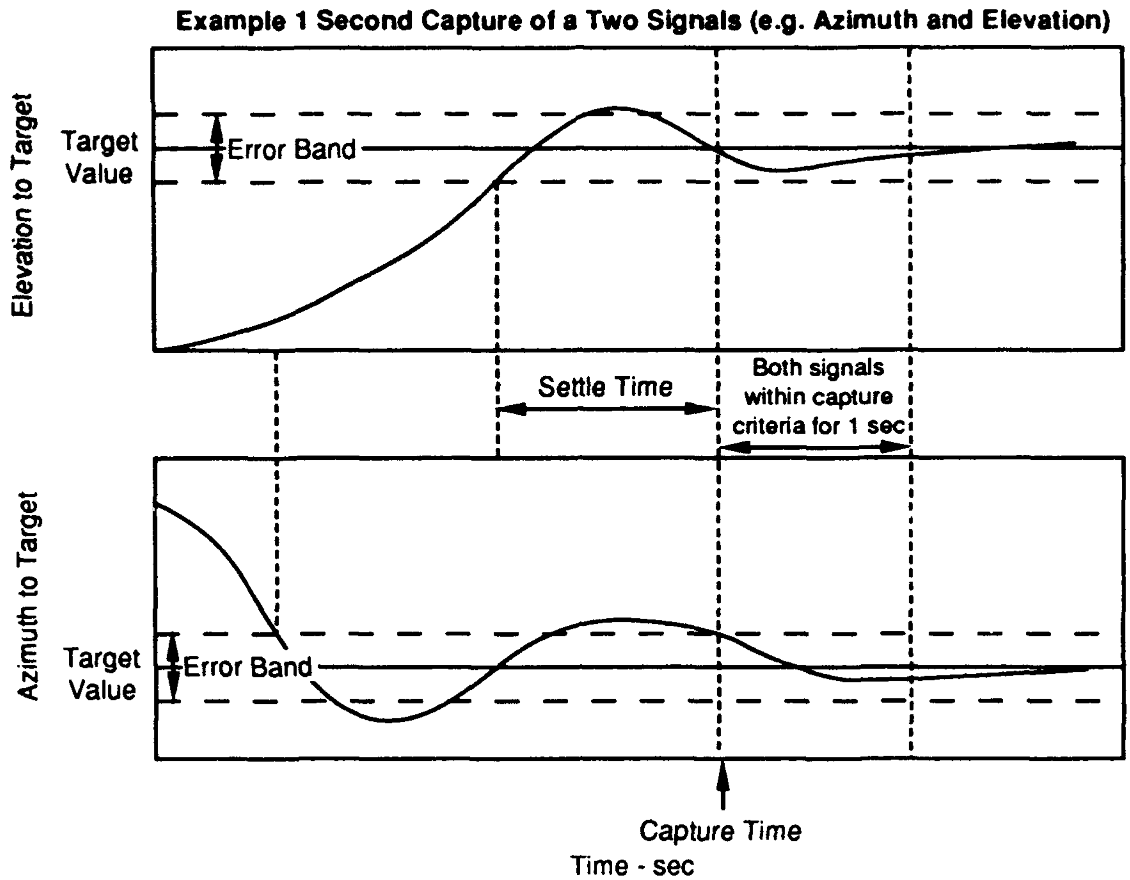



**Figure C-2. Definition of Capture Time and Settle Time for Dual-Axis Task**

## Appendix D
## Detailed Simulation Data

This appendix includes detailed data from the three simulations including descriptions of the dynamics tested, statistical analyses of the measure of merit data, and pilot comments and ratings. The first few pages of this appendix are used to give additional background for the statistical analyses. The remainder of this appendix includes the simulation data grouped by maneuver. Several versions of a maneuver may exist (these will be labeled as TEST 1, TEST 2, etc.) if the maneuver was flown using different flight conditions, different simulation models, or different variations on a maneuver (such as capturing different pitch attitudes). Also various statistical analyses may have been conducted depending upon the test data available. These are labeled as ANALYSIS A, ANALYSIS B, etc. The first page of each STEM will be used to describe the analyses conducted and the data contained for that particular test.

## Key to Numerical Summaries

Results of the statistical analyses are summarized in numerical form and included for each maneuver. The following describes the information shown on these summary sheets:

Column 1 contains a reference number for the measure of merit. This was used during Review Team analyses but is now of no real importance.

Column 2 contains the name of the measure of merit.

Column 3 contains the model significance level. This is the significance level for the overall statistical analysis model for that particular measure of merit. At the 95% significance level (SIG=0.95), the probability of chance alone generating the observed change is 1 in 20. If PR=-999, then the significance could not be calculated.

Column 4 contains the variable name for the design parameter being varied.

Column 5 contains the significance level for a particular design parameter and measure of merit. This is an indication of the confidence with which that design parameter's average measures of merit can be determined.

Columns 6-9 contain the average measure of merit values for the design parameter at it various test levels. Usually only two levels were tested for each design parameter, so the eight and ninth columns will be blank or contain zero.

Column 10 indicates the percent change in the measure of merit for that design parameter variation. The percent change was calculated as an average change, ie. (mean1-mean2)/mean2 averaged with (mean2-mean1)/mean1.

Column 11 indicates the ratio between the percent change in the measure of merit over the percent change due to pilot variability for that measure of merit.

Column 12 indicates the outcome of the design parameter rules (described on next page) for that combination of measure of merit and design parameter.

Column 13 indicates the outcome of the pilot variability rules (described on next page) for that combination of measure of merit and design parameter. This column is valid if data from only one pilot is available.

Column 14 indicates the outcome of the overall rules (described on next page) for that combination of measure of merit and design parameter. This column is valid if data from only one pilot is available.

## Rules Used to Classify the Success of Measures of Merit

### Design Parameter Rules

The change in measure of merit value due to the design parameter variation was graded as:

| | |
|---|---|
| Strong | SIG ≥ 0.9 and Δ ≥ 40% |
| Potentially Strong | (SIG ≥ 0.9 and Δ ≥ 20%) or (SIG ≥ 0.8 and Δ ≥ 40%) |
| Potentially Poor | (SIG ≥ 0.9 and Δ ≥ 10%) or (SIG ≥ 0.8 and Δ ≥ 20%) |
| Poor | Remainder of Cases |

Notes:
1. SIG = Statistical Significance Level
2. Δ = Change in Measure of Merit Due to Design Parameter Variation

### Pilot Variability Rules

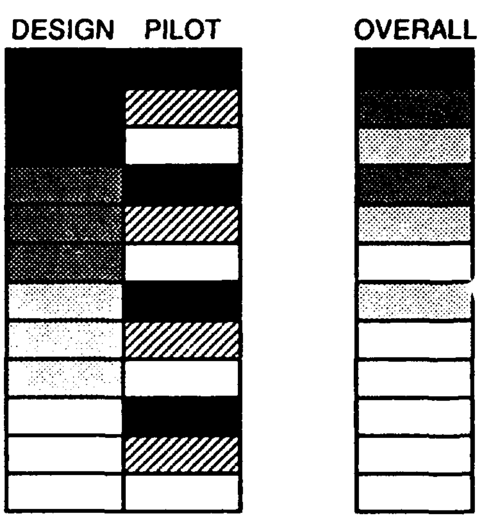
The overall success of the measure of merit was then modified based on the amount of pilot variability as:

| | |
|---|---|
| Overall Rating Same as Design Parameter | Ratio ≥ 2.0 |
| Overall Rating One Lower Than Design Parameter | 1.0 ≤ Ratio < 2.0 |
| Overall Rating Two Lower Than Design Parameter | Ratio < 1.0 |

Notes:
1. Ratio = Ratio of Change in MOM Due to Design Parameter Variation Over Change in MOM Due to Pilot

### Overall Rules

A summary of the possible overall grades for the measure of merit analysis is shown below.



## Data Contents for STEM 1: Tracking During High AOA Sweep

TEST 1: AOA Command systems

- Summary of Design Parameter Variations Tested
- Numerical Summary of Statistical Analysis
- Bar Graphs of Measures of Merit
- Design Parameter Correlations, Pilot Variability, and Overall Correlations
- Pilot Comments

## Summary of Design Parameters Tested for STEM 1

Test variables:

PMAX: Indicates the maximum stability axis roll rate available from a full stick input. Implemented as a schedule based on AOA. Also directly affects the lateral stick sensitivity:

- (-) low, 180°/s for AOA≤5°, 80°/s at AOA=15°, 40°/s at AOA=30°, 10°/s at AOA=60°
- (+) high, 180°/s for AOA≤5°, 100°/s at AOA=15°, 70°/s at AOA=30°, 30°/s at AOA=60°

TR: Indicates the stability axis roll mode time constant. Implemented as a schedule based on AOA:

- (-) slow, 0.6 s for AOA≤5°, 1.0 s at AOA=15°, 1.8 s at AOA=30°, 3.0 s at AOA=60°
- (+) quick, 0.6 s for AOA≤5°, 0.8 s at AOA=15°, 1.0 s at AOA=30°, 2.4 s at AOA=60°

CAP: Indicates a variation in $\omega_{sp}$. $\omega_{sp}$ scheduled linearly with knots equivalent airspeed (KEAS) with the following value at 100 KEAS:

- (-) 0.5 rad/sec, Level 1/2 boundary for high AOA tracking from MCAIR research
- (+) 0.75 rad/sec, Solid Level 1 value for high AOA tracking from MCAIR research

ZSP: A schedule of ZSP was implemented based on AOA:

For low AOA (≤10°), ZSP maintained at:

- (-) 0.5, Level 1 from MIL-STD-1797A but generally accepted as borderline low
- (+) 0.80, Level 1 from MIL-STD-1797A and generally desirable for tracking

For high AOA (30°), ZSP maintained at:

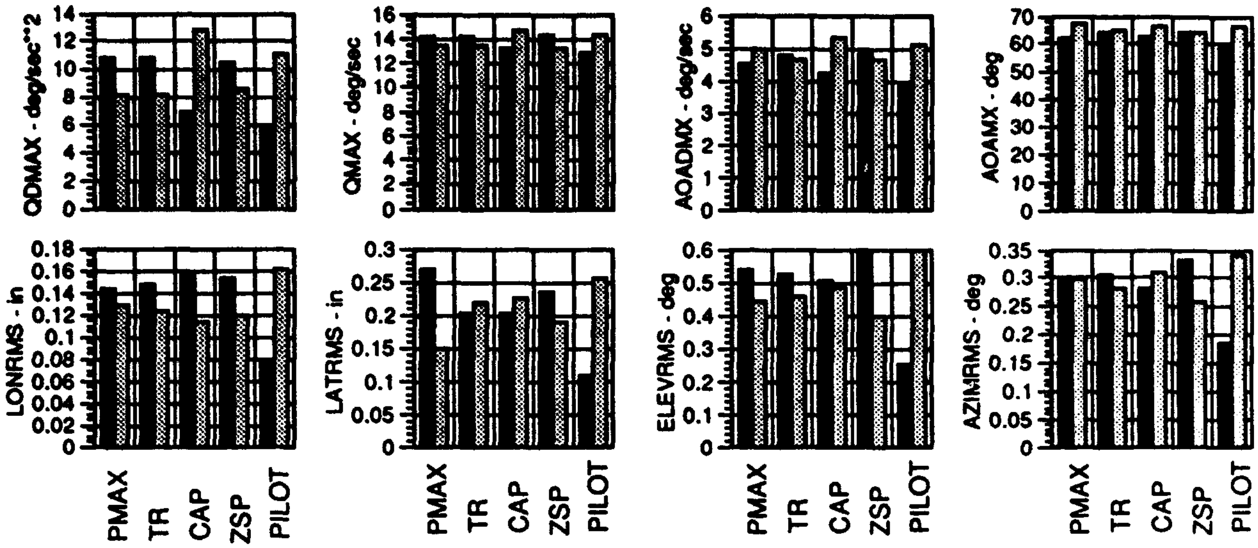
- (-) 0.6, Level 1/2 boundary for high AOA maneuvering from MCAIR research
- (+) 1.1, Solid Level 1 value for high AOA maneuvering from MCAIR research

### Test Matrix (Pilots A,F)

| Lon Config | Lat Config | PMAX | TR | CAP | ZSP |
|---|---|---|---|---|---|
| 191 | 32 | low (-) | slow (-) | 0.5 (-) | 0.5/0.6 (-) |
| 192 | 33 | high (+) | slow (-) | 0.5 (-) | 0.8/1.1 (+) |
| 192 | 33 | slow (-) | quick (+) | 0.5 (-) | 0.8/1.1 (+) |
| 191 | 35 | high (+) | quick (+) | 0.5 (-) | 0.5/0.6 (-) |
| 193 | 32 | low (-) | slow (-) | 0.75 (+) | 0.8/1.1 (+) |
| 194 | 33 | high (+) | slow (-) | 0.75 (+) | 0./0.6 (-) |
| 194 | 34 | low (-) | quick (+) | 0.75 (+) | 0.5/0.6 (-) |
| 193 | 35 | high (+) | quick (+) | 0.75 (+) | 0.8/1.1 (+) |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | QDMAX | 0.6967 | PMAX | 0.765 | 10.834 | 8.1633 | 0 | 0 | -0.287 | 0.40 | 4 | 3 | 4 |
| | | | TR | 0.755 | 10.755 | 8.2484 | 0 | 0 | -0.269 | 0.38 | 4 | 3 | 4 |
| | | | CAP | 0.985 | 6.8838 | 12.879 | 0 | 0 | 0.668 | 0.94 | 1 | 3 | 3 |
| | | | ZSP | 0.452 | 10.452 | 8.7095 | 0 | 0 | -0.183 | 0.26 | 4 | 3 | 4 |
| | | | PLT | 0.970 | 5.7498 | 11.148 | 0 | 0 | 0.712 | | | | |
| 8 | QMAX | 0.7283 | PMAX | 0.791 | 14.205 | 13.47 | 0 | 0 | -0.053 | 0.52 | 4 | 3 | 4 |
| | | | TR | 0.757 | 14.165 | 13.514 | 0 | 0 | -0.047 | 0.46 | 4 | 3 | 4 |
| | | | CAP | 0.980 | 13.207 | 14.657 | 0 | 0 | 0.104 | 1.02 | 3 | 2 | 4 |
| | | | ZSP | 0.900 | 14.419 | 13.324 | 0 | 0 | -0.079 | 0.77 | 4 | 3 | 4 |
| | | | PLT | 0.969 | 12.878 | 14.261 | 0 | 0 | 0.102 | | | | |
| 11 | AOADMX | 0.9231 | PMAX | 0.788 | 4.5091 | 4.9667 | 0 | 0 | 0.097 | 0.33 | 4 | 3 | 4 |
| | | | TR | 0.275 | 4.7979 | 4.6556 | 0 | 0 | -0.030 | 0.10 | 4 | 3 | 4 |
| | | | CAP | 0.987 | 4.2669 | 5.3076 | 0 | 0 | 0.220 | 0.74 | 2 | 3 | 4 |
| | | | ZSP | 0.335 | 4.8215 | 4.6439 | 0 | 0 | -0.038 | 0.13 | 4 | 3 | 4 |
| | | | PLT | 0.996 | 3.8169 | 5.1136 | 0 | 0 | 0.297 | | | | |
| 20 | AOAMX | 0.9748 | PMAX | 0.955 | 61.975 | 66.997 | 0 | 0 | 0.078 | 0.66 | 4 | 3 | 4 |
| | | | TR | 0.263 | 64.118 | 64.689 | 0 | 0 | 0.009 | 0.08 | 4 | 3 | 4 |
| | | | CAP | 0.921 | 62.382 | 66.906 | 0 | 0 | 0.070 | 0.59 | 4 | 3 | 4 |
| | | | ZSP | 0.161 | 64.597 | 64.204 | 0 | 0 | -0.006 | 0.05 | 4 | 3 | 4 |
| | | | PLT | 0.992 | 59.195 | 66.582 | 0 | 0 | 0.118 | | | | |
| 42 | LONRMS | 0.9999 | PMAX | 0.935 | 0.1431 | 0.1284 | 0 | 0 | -0.109 | 0.14 | 3 | 3 | 4 |
| | | | TR | 0.993 | 0.147 | 0.1241 | 0 | 0 | -0.170 | 0.21 | 3 | 3 | 4 |
| | | | CAP | 1.000 | 0.1549 | 0.1123 | 0 | 0 | -0.327 | 0.41 | 2 | 3 | 4 |
| | | | ZSP | 0.999 | 0.1537 | 0.1196 | 0 | 0 | -0.253 | 0.32 | 2 | 3 | 4 |
| | | | PLT | 1.000 | 0.0775 | 0.1606 | 0 | 0 | 0.795 | | | | |
| 43 | LATRMS | 0.9753 | PMAX | 0.996 | 0.2682 | 0.1493 | 0 | 0 | -0.620 | 0.65 | 1 | 3 | 3 |
| | | | TR | 0.307 | 0.2024 | 0.2202 | 0 | 0 | 0.085 | 0.09 | 4 | 3 | 4 |
| | | | CAP | 0.574 | 0.2004 | 0.2241 | 0 | 0 | 0.112 | 0.12 | 4 | 3 | 4 |
| | | | ZSP | 0.762 | 0.2347 | 0.1889 | 0 | 0 | -0.219 | 0.23 | 4 | 3 | 4 |
| | | | PLT | 0.998 | 0.1088 | 0.254 | 0 | 0 | 0.953 | | | | |
| 44 | ELEVRMS | 0.9522 | PMAX | 0.827 | 0.5381 | 0.4469 | 0 | 0 | -0.187 | 0.19 | 4 | 3 | 4 |
| | | | TR | 0.710 | 0.526 | 0.4601 | 0 | 0 | -0.134 | 0.14 | 4 | 3 | 4 |
| | | | CAP | 0.188 | 0.5034 | 0.4827 | 0 | 0 | -0.042 | 0.04 | 4 | 3 | 4 |
| | | | ZSP | 0.989 | 0.5963 | 0.3994 | 0 | 0 | -0.412 | 0.42 | 1 | 3 | 3 |
| | | | PLT | 1.000 | 0.2501 | 0.597 | 0 | 0 | 0.984 | | | | |
| 45 | AZIMRMS | 0.9902 | PMAX | 0.165 | 0.2927 | 0.2974 | 0 | 0 | 0.016 | 0.02 | 4 | 3 | 4 |
| | | | TR | 0.694 | 0.3063 | 0.2826 | 0 | 0 | -0.081 | 0.13 | 4 | 3 | 4 |
| | | | CAP | 0.808 | 0.2816 | 0.3116 | 0 | 0 | 0.101 | 0.16 | 4 | 3 | 4 |
| | | | ZSP | 0.993 | 0.3334 | 0.2592 | 0 | 0 | -0.254 | 0.40 | 2 | 3 | 4 |
| | | | PLT | 1.000 | 0.1865 | 0.3406 | 0 | 0 | 0.639 | | | | |

STEM 1


QDMAX - deg/sec**2
QMAX - deg/sec
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LATRMS - in
ELEVRMS - deg
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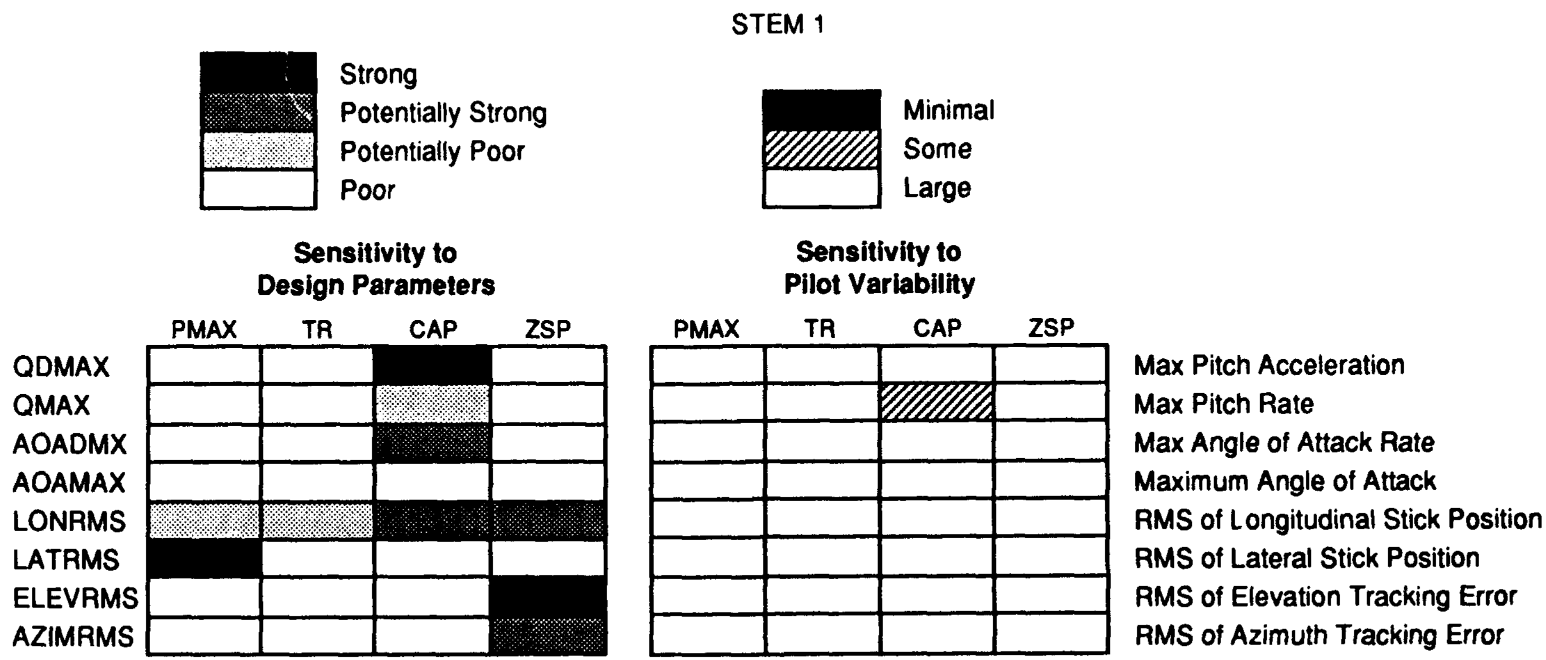
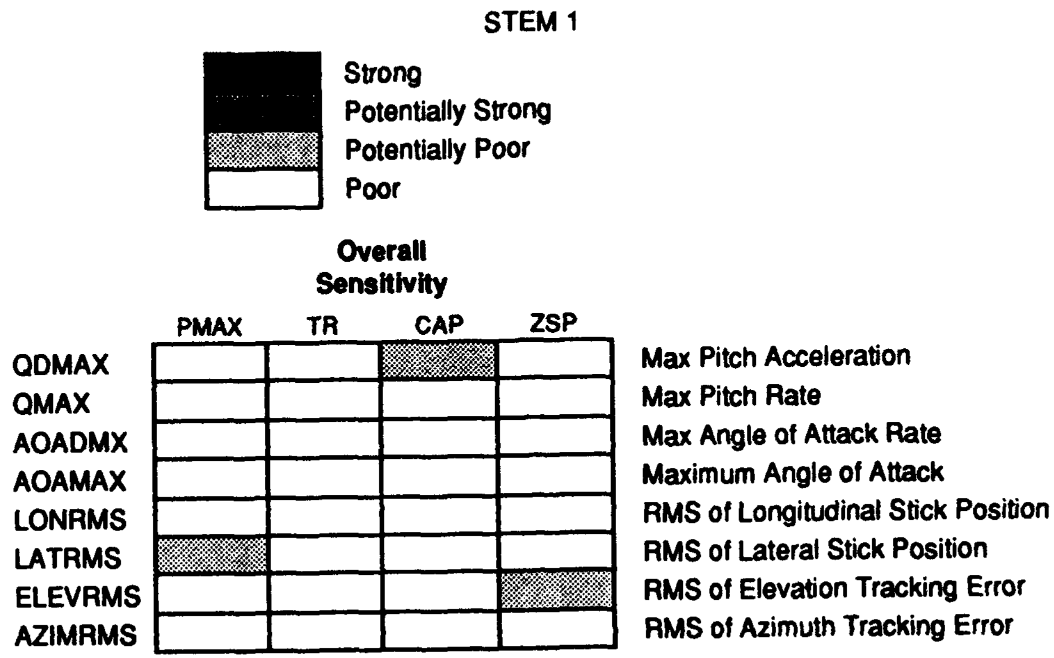
PMAX
TR
CAP
ZSP
PILOT


STEM 1
Strong
Potentially Strong
Potentially Poor
Poor
Minimal
Some
Large
Sensitivity to Design Parameters
Sensitivity to Pilot Variability
PMAX
TR
CAP
ZSP
PMAX
TR
CAP
ZSP
QDMAX
QMAX
AOADMX
AOAMAX
LONRMS
LATRMS
ELEVRMS
AZIMRMS
Max Pitch Acceleration
Max Pitch Rate
Max Angle of Attack Rate
Maximum Angle of Attack
RMS of Longitudinal Stick Position
RMS of Lateral Stick Position
RMS of Elevation Tracking Error
RMS of Azimuth Tracking Error


STEM 1
Strong
Potentially Strong
Potentially Poor
Poor
Overall Sensitivity
PMAX
TR
CAP
ZSP
QDMAX
QMAX
AOADMX
AOAMAX
LONRMS
LATRMS
ELEVRMS
AZIMRMS
Max Pitch Acceleration
Max Pitch Rate
Max Angle of Attack Rate
Maximum Angle of Attack
RMS of Longitudinal Stick Position
RMS of Lateral Stick Position
RMS of Elevation Tracking Error
RMS of Azimuth Tracking Error

STEM 1
PILOT A
LONGITUDINAL CONFIGURATION 191
LATERAL CONFIGURATION 32

Okay, we're ready for a tracking data run. Bobbling around. Just not quite holding him where I want. Real good tendency to PIO longitudinally. Laterally, it's okay. I can get there about 50% of the time realistically. It's like I'm averaging on him but it's bouncing off. This is not a good fine tracking airplane. It's constantly oscillating plus or minus 5 to about 8 mils. And it's mostly longitudinally but it's also wandering laterally. Now I am past 30 AOA. A bit of tendency to drop off in lag as the stick forces go heavier and heavier here at the end. And at the end he just runs away. I can't keep up. I don't know how to assign ratings to that. I think your RMS value is the best measure. It's hard to keep on. The airplane wanders longitudinally and laterally. Difficult to do the fine control. Especially when the stick comes further aft. But I would say I was averaging inside my 10 mil pipper about 50% of the time. The rest of the time he was bouncing around.

And now I'm going to do the same task but with attempts to capture him on the four corners of the 50 mil reticle. Going to the bottom. Oh man, is that lousy when you do a large acquisition. It bounces all over creation. Up the other way, bounce, bounce, two big oscillations and then several small ones. There's always a constant state of low oscillation when I'm doing longitudinal repositions. Set up in the middle, do some lateral. Here's lateral aileron. Pretty precise laterally. One overshoot, two overshoots, then it's on, lateral again, same, now lateral with rudder. Now some longitudinal. A little more sluggish now so it makes it slightly more predictable. Still one big oscillation and then 2 little ones. Pretty sluggish. Getting heavy in controls. I'm just going to try and track him now and he's getting away. There's full aileron. He still got away. The rate of angle of attack increase there was a little bit high for me to do any sort of integrated test block at a given angle of attack. If we're going to do an integrated test block type maneuver where I'm trying to do a reposition longitudinally with aileron and laterally with rudder then we need to have him coming down the hill faster or something so that my Ps is better so that I can stay at a given angle of attack longer. But for now let's just go ahead and do it the way we just did it. Because it's pretty good. And I'll just try to be a little quicker.

STEM 1
PILOT F
LONGITUDINAL CONFIGURATION 191
LATERAL CONFIGURATION 32

That tracking was not satisfactory. It felt like it was a lot of slow response to pitch inputs. Let me phrase that. It's very pitch sensitive but the lag time between stick input and moving the nose seemed to be noticeable. It had this very spongy effect. I'd pull on the stick and then the nose would start travelling and travel rapidly. When I went to stop it the nose continued traveling. When I tried to stop it, it caused an overshoot. It seems to me there's a delay in the flight control system and then once the motion starts it's fairly rapid. Certainly it's loose. In other words you can't stabilize the nose. You can't stop the motion. When you start the motion, it starts in a lag, accelerates, and when you stop it it overshoots and causes you to overcorrect. You get yourself in a

very sloppy PIO. At higher angle of attack it started going away a little bit because I think I saturated the flight control system in pitch, so there wasn't as much pitch input because as I slowed down I got to higher angle of attack. I'm tracking sort of reasonably well now compared to before. At angle of attack I'm losing some control over roll. Now I don't have it. What happened there is the configuration is not only sensitive in pitch and I'm starting to get to high angle of attack, I also didn't have roll authority which I needed to correct the pipper back to the target. The sloppiness is really apparent at the beginning of the task when I first trying to get into tracking. My ability to get into his plane of motion and track him is very poor with this configuration due to the sloppy pitch. Then the next time I have a problem is when we get into the post stall area and the velocity vector starts degrading and the plane of motion starts changing again, and then I don't have the roll authority to correct. This is the one I'm talking about. See how I'm trying to pull lead. I'm trying to match a plane. It's real sloppy in pitch. That happened every time. I give an input, there's no motion, then all of sudden it just pops out in front of him. See I got a PIO right there, and I'm still in mil. Let's get a little angle of attack built up. Still in mil. Airspeed is bleeding down. Angle of attack is at 17. Coming to min ab now. Airspeed still bleeding. I'm at 22 degrees alpha, and this probably is the best tracking I'm going to get because I've got enough airspeed to stay in a plane of motion with him for some period of time. But once I go to 30, the roll is starting and my velocity vector is starting to drop. You'll see, my wings are starting to level out. And the more rapidly this thing decelerates, the more my wing is going to start leveling. And there I'm coming to 45 degrees, 50, there's full lateral but I've got to correct again but I don't have anything left. There's 80 alpha.

STEM 1
PILOT A
LONGITUDINAL CONFIGURATION 192
LATERAL CONFIGURATION 33

A little easier to get a steady track this time. I'm basically holding it inside about plus or minus 4 mils most of the time. Plus minus 5 all the time. Little bit of dither around now. I'm definitely holding it 90% of the time inside 10 mils. A little bit of left/right wander now. No significant problems with AOA, through 45°. Starting to get away from me longitudinally. Almost to the aft stop. Getting off laterally and I'm at the aft stop. And he drives out. Okay, we'll do one of those for data. I find it a little bit hard to track when we're down around 12 or 13 alpha. It's a little bit light. Just a trim problem. I'm not trimming throughout and it seems like it's almost a 1 g situation here right now even though we're at 4 g. I don't feel much aft pressure on the stick. It's settling down now. Got a nice steady track now. In to min blower through 15. Speed's decaying nicely. Nice steady track. Coming up on 20 going to max blower. The speed is still decaying. Pretty nice, steady track. I'm tracking the centroid, the black dot that's sort of in the centroid of the fuselage there. Coming through 25 alpha, no significant changes, the bobbles are plus or minus 5 mils pretty well all around the circle. I'm doing only aileron as lateral correction and primarily the workload seems to be longitudinal. Coming through 30 alpha. Starting to drive out of it a little there. I got it back. Coming through 40 alpha, starting to get away from me now. Feels like a non-linear increase in the amount of aft stick required. Starting to drive out to the top right, up through 60 alpha. And I'm aft stop. And he drove out. But I tracked him right up to

the moment I was at max control power. Pretty nice tracking. I could pretty well hold him all the time. Definitely 90%. He'd bobble out and then I'd get him back in. The worst tracking was down below about 14 alpha where I thought I had things stabilized as far as geometry went but very light stick forces. So you're almost in the neutral band, the friction band, of the stick and so constantly playing in and out of that and it was hard to get a track on them. But once we got above about 14 alpha I could settle down and track him well within what I'd want for desired tolerances. So no real problem areas I saw except below 14 alpha longitudinally and then above about 50 or 55. Laterally it became harder to keep him but I could keep him in with moderate workload.

Okay, I'm ready for the repositioning run. We're basically stabilized now, he's on the bottom of the circle, now to the top, one overshoot and on. Coming up on 15 alpha. One overshoot and then a couple of fine corrections. Now going laterally with aileron, coming up on 15 alpha still, one, two overshoots, the other side. Basically deadbeat, pretty nice. Now rudder, comes over, little trickier, got to hold it just for the side slip, now the other way. It can do it. It's kind of linear, there's no real step input required. Coming up on 20. Here's longitudinal. He's bobbling around plus or minus 10 or so. Here's the other way. One overshoot and in. Now back up again. Pretty easy to get a capture. Here's lateral at 20 alpha. One big overshoot and then slowly damped in. I've got to be careful. Rudder is weird because you have to leave the input in. But it's a pretty reasonable tactical thing to do is try and slew him around with rudder. Twenty five alpha. Trying longitudinal. One overshoot and in. The other side. Approaching 30 alpha. Here's an aileron laterally now. One overshoot and he's in. Again, one overshot and slowly, slowly, there he is in now. Okay, here comes 35 alpha. One overshoot longitudinally and he's in, now the other way, stick forces are getting higher, nice deadbeat just because there's less slop in the stick. Up to 35. Nice and stable. It's better than it used to be because we're getting near a performance limit. It doesn't overshoot so badly. The rate is a little lower so I can predict it better. Coming through 45, going to two handed operation now just because of the forces. Okay, he running away from me in pitch power and he's gone out of the circle. Generally pretty good. A gradual degradation as time went on. The worst handling qualities are below 13 or 14 AOA because of too close to the neutral band of the stick. Laterally the characteristics don't seem to change much. A constant variation throughout the entire envelope, plus or minus about 5 mils all directions and above about 40 AOA the stick forces get so high and I've been holding for so long when I go to two handed it doesn't change the handling qualities just makes it easier to hold and then it rapidly goes from 40 up to the maximum of 70 and I purely just become performance limited. Until I started running out of control authority, I could always get from one tracking solution to another for repositions within a second or so, which is desirable. It was nice and responsive. Just a little bit hard to settle down to a really smooth track.

STEM 1
PILOT F
LONGITUDINAL CONFIGURATION 192
LATERAL CONFIGURATION 33

I'm getting a real minor pitch oscillation in the fine tracking part of this maneuver. I'm having some lateral oscillations. It's very hard to stabilize it. I don't know what to say about that configuration.

Initially when I rolled over it felt more stable. It wasn't as sloppy but in the fine tracking exercise it seemed to have the same tendency to be sloppy but through a much more narrow range than the previous one. In other words, when I went to track I put a little aft stick in, nothing would happen, all of a sudden the pipper would float up but I could stop it quicker. It seemed like the control loop was a little tighter but still had a tendency to oscillate 10 to 15 mils. The big pipper is on the target he whole time. The little one is walking all around the nose of the aircraft and I cannot stabilize it onto the tracking reference that I've selected. So it seems to be that you still have some slop in the flight control system but the range is about 1/3 of the previous configuration (longitudinal configuration 191, lateral configuration 32).

STEM 1
PILOT A
LONGITUDINAL CONFIGURATION 192
LATERAL CONFIGURATION 34

Ready to set up for tracking. Getting to conditions and basically stable now. Again, the stick force per g seems strange so I'm releasing the stick now. Moving it forward as the geometry sorts itself out. Some longitudinal problems. Not much lateral coming through 13 AOA. Got a pitch bobble of about plus or minus 5. Now it's settling down. And now just a slow wander around plus or minus 5 in all axes as I attempt to settle it out. I'm into full blower, 20 AOA, no big characteristic changes that I've seen. A long gun burst and basically right in the middle of the centroid throughout. Driving my gains up for that doesn't make much change. I can still hold him nice and solid. It's not just camping directly on him but it's not bad. Coming through 30 AOA, the stick force gets to be a little bit heavy in the arm. And as a result I tend to occasionally lag him a little bit in pitch. Starting to fall below him. Looking up 10 degrees at him now. Coming through 40 AOA, he's getting away from me just a hair. I've got him back again. And the same thing. Not much roll authority and he's out of there. Significant increase in the stick force required to hold him towards the end makes it difficult to keep a precise track. But all over, pit is pretty nice. I could hold him fairly comfortably throughout until I got right towards the end. Again, stick force per g seems too light at the lower AOAs. But when I was smooth in the heart of the envelope from about 14 AOA up to about 40 AOA, it just held inside a 10 mil circle the whole time.

Now we're coming for repositions. About 13 to 15 AOA right now. Pull to the bottom of the circle, one overshoot and slowly releasing the stick to ease him on. Going to the center. Tracks okay laterally with aileron. Other way. Small overshoot, doubled up a little bit, about 2 overshoots and then settled the other way. And again a little bit hard to predict but not too bad. Works okay longitudinally. Here we go with rudder. From the center, he's on, back to center, he's on, just straight linear with rudder. Nothing abnormal. Here's 20 alpha. Tracking longitudinal, going the other way. One overshoot and settled. Looks good and releasing. And up the other side. One overshoot and settled. The timing is good. Control is pretty precise. Twenty AOA. Laterally, on the side, going to the other. Pretty nice control harmony, about feels equal longitudinally and laterally. Very small overshoots laterally right now. Twenty-five AOA. Longitudinally, pulling up, and just gentle fine control, feels natural. Approach 30 AOA, again the tendency to overshoot is going away as the longitudinal response is dropping off. Okay, coming through 40 AOA, here's

a lateral reposition. Nice and precise, predictable. Here comes a longitudinal reposition at 45, going to 2 hands. Very predictable now because we're getting to the edge of the control power. Not much tendency to overshoot and we're at the end of the run. Overall, that felt quite similar to the first one. Maybe slightly better. A little bit easier to predict a fine track, pretty nice handling qualities throughout. The time it took for repositions was good and nicely matched between longitudinal and lateral. No real complaints. That was not a bad tracking platform. And really no significant problems with changes in AOA. Except, of course, the stick force per g at the initial part of it. I'm not sure if that's just a geometry problem but I'm seeing 3.8 g on the airplane sustained and yet feeling very light stick forces so I don't understand that.

STEM 1
PILOT F
LONGITUDINAL CONFIGURATION 192
LATERAL CONFIGURATION 34

Okay, it may just be me. That entry turn always has that little pitch overshoot when I come down. It seems to be a little more stable probably because I've got full aft stick at a little higher angle of attack. Tracking is much more satisfactory than the previous ones. I'm running into a little saturation of roll and pitch simultaneously. It may just be the way I'm flying, but when I rolled in with this configuration I had those same oscillations. I put my nose on the target, it starts to drift forward, I go to correct, I get the big pitch surge. Around 25 degrees, I begin to notice the difference. It got a lot more stable, and tracking wasn't a problem. So it seemed a little bit loose in pitch at low angles of attack but as soon as I got up to the high angles of attack it stiffened up and I had good control feedback in pitch and in roll up until the very end when the pitch axis started getting saturated and the velocity vector was starting to generate toward the vertical down. I had very little capability to correct in roll to keep track in the target and then I saturated pitch and roll at the very end.

STEM 1
PILOT A
LONGITUDINAL CONFIGURATION 191
LATERAL CONFIGURATION 35

Setting up for a tracking run. We're getting into the envelope here and about stabilized. A little bit of a PIO there as I attempt to fine tune it as we transition off of the poor stick qualities and now he's a pretty steady track. Again, a multi-axis bobble at about the limits of desired criteria but still just fine for this kind of tracking. This would be a useful guns weapon here. Coming through 20 AOA. It drifted off a little, now I'm back. Drifted off him again, now I'm back on. That was a lateral drift to the right. Longitudinally it's not bad. It's a little tough to correct laterally there. Holding him most of the time. Lot of the time dead center. Almost all of the time somewhere within the desired area. Coming through 30 AOA. Stick force starts to become apparent there. Tracking him okay. He's wandering to the edge of the circle. Now, getting away from it longitudinally and back on it now. Workload goes up a little bit as the rate of stick movement increases as the AOA gets away here. Very hard to track now that we get above about 50 AOA.

Setting up for the reposition run. I've got him on the bottom of the circle. Now to the top of the circle. One, two overshoots and then inside about a plus or minus 20 mil circle. Slowly fading it down to a 10 mil circle. A little bit of tendency to PIO longitudinally. It's at 15 AOA. Lateral reposition. Pretty quick in aileron. I would expect more aileron to be required to make that big a change. You've got to be careful with the aileron. But I can get used to it. It's just a fairly sensitive aileron. Approaching 20 now. The airplane is a little twitchier than the other model. There's 20 AOA. A little harder to predict. Both longitudinally and laterally. Here's 20. Going lateral, one overshoot and now plus or minus 7 or 8 mils. Going longitudinal, one overshoot of plus or minus more than 10. Here's 25. Trying for a longitudinal reposition the width of the circle. One overshoot, one undershoot and in. Now the other way. I'm overdriving it slightly to speed up the rate but the rate I'm ending up with is good, just fine. Here comes the lateral reposition at 35. That's nice now. That's a reasonable amount now. Coming at 40 for longitudinal reposition, pulling him up, and again it becomes more predictable as the AOA goes up and now I'm just going to track him. As the AOA goes high it becomes easier and easier to do a reposition predictably just because you're at the performance limits and you don't end up with an overshoot and then an undershoot. You just get there basically deadbeat. Okay, so overall, reasonable harmony between the two of them but for most of the band I'd say they were a little bit too sensitive. It was getting difficult to keep from PIOing since the response was so quick. I was wandering around a lot. I tend to undershoot or overshoot and then undershoot. It took a little work to settle down. The rates were desirable. I could get all my repositions done within the amount of time required.

STEM 1
PILOT F
LONGITUDINAL CONFIGURATION 191
LATERAL CONFIGURATION 35

There's some tracking. I'm getting a little bit of slop. I think it's going to straighten itself out here. Maybe not. There's a little bit of slop around about a 20 mil area. Now it's stabilized out. I'm at 26 degrees angle of attack. Okay, going up to 30. It's a lot of roll. The system seemed real sensitive in roll there for a second. The only way I can discriminate between this one and the previous one (Longitudinal configuration 192, lateral configuration 34), is that the previous one had slop around a 15 mil region. This seems to be more like 25, so I'm getting some lateral float. And I'm getting some pitch oscillations, and they're covering about the inner 50% of the 50 mil reticle. You don't have any gross oscillations around the tracking index due to flight control inputs but you do have a degree of sloppiness that covers about a 25 mil area around where you're trying to track. You set it in there, and it starts wandering off and floating and slight control inputs bring it back across and then it floats off again. So it doesn't seem to be as tight of a flight control system as a previous one. These configurations feel basically the same to me upon entry. I mean they're not really satisfactory. For anything below about 15 degrees they feel like there's a lot of slop in pitch. Once you get it loaded up, then I can see differences.

STEM 1
PILOT A
LONGITUDINAL CONFIGURATION 193
LATERAL CONFIGURATION 32

Going to track him right through the high alpha region. Having a bitch of a time trying to initially settle onto it. Till we're stabilized at about 14 AOA and then it works. Sort of a slow frequency left/right oscillation which I'm slowly getting damped out. And a higher frequency longitudinal oscillation which I have to be careful not to excite. Very similar to the last two. I'm not seeing a lot of variation here. This one seems a little worse again. Just hard to settle down. Okay, let's settle in track here. My pauses in the shooting were due to my left/right slow frequency oscillation. I'm holding him within the pipper all the time now. I have been since about 18 AOA. Coming through 30. No significant changes. Stick force getting higher. Stick is most of the way. Having to put it full aileron now. And he's away out of it. Seventy-five AOA.

Setting up for the reposition run. Approaching 15 AOA. Trying a longitudinal reposition. A little tendency towards PIO if I'm too quick. Got to be smooth. Little hard to predict, little bit twitchy. He's wandering left/right again at that same slow frequency oscillation. Now some lateral at 15. That's an acceptable rate left/right for repositions. Let's try and do it quick now. And one overshoot when I do it fast. Settles down okay with a constant longitudinal oscillation of about 5 mils or so. Now at 20. Longitudinal works pretty well. Fairly quick. Slowly decaying in speed. I went to full blower a little soon just to slow down the process. Laterally, one overshoot and back on. Okay, I'm going to try rudder quickly. Again, it's purely linear with rudder. Let's get back in the middle and do rudder the other way at 23 AOA. And again just a linear function with rudder and the amount of control power available. Now at 25. It's fairly quick longitudinally. It's a little hard to predict but it's not bad. Let's go to a track. And I walk him in to about 3 seconds to a happy tracking solution. Coming through 40 AOA. Try a lateral reposition. A little bit more sluggish now. A little harder to get on as a result and he's just about out of the performance capability now. I think it is a little bit oversensitive for the smooth track. The response was quick enough in all three axes. Rudder maybe seemed a little bit sluggish but that was just maybe the amount of side slip available. It seems to steady out from about 14 to about 40 and then it ramps up again from about 40 up to 70. Tracking was okay. The repositions were hard to predict. Generally I had more than one oscillation. I'd either get an undershoot or an overshoot, then I'd think I'd be correcting it in and it would pause or it would go the other way and it would take me two pulses and a little bit of time to settle in. So that made it a little tough to predict. Not a bad tracking airplane. Always around plus or minus 5 mils directionally and longitudinally.

STEM 1
PILOT F
LONGITUDINAL CONFIGURATION 193
LATERAL CONFIGURATION 32

This one feels tight already. The roll control feels much tighter on this one. The pipper is not dancing around as much. Okay, I get a little PIO there. It seems to be sensitive to inputs because it moves almost immediately. The tracking seems to be reasonable up here at the high

angles of attack again. The drift rate in this pipper is predictable. When it goes off it isn't a float. You can see it walking off and you can stop it and bring it back. You can control it a little bit better. This one seems to be a lot more stable and damped as far as pitch oscillations go. In other words, I don't get a wide swing in pitch, although as soon as I touch the stick the pipper moves. It's just tighter in the tracking function. I did get a roll oscillation there which might have been my hand input but it seemed like it also moved rapidly in roll. The pipper rate is more directly responsive to stick inputs. What happens at extreme angles of attack, if you have the slightest lateral error it's very difficult to correct it. Even though you got the pitch authority you just don't have the roll capability to do precise tracking. That starts occurring around 45°. If you have a lateral error introduced you just don't have the authority to come back and correct it. I'd say that configuration is very sensitive in pitch but it's a very tight control system in the middle of the maneuver.

STEM 1
PILOT A
LONGITUDINAL CONFIGURATION 194
LATERAL CONFIGURATION 33

Okay, we're settling down now. Pretty bouncy longitudinally. Boy, this a lousy tracker. Cancel all those things I said about not seeing much change. I really dropped my gains to fly this. Look at that thing bounce. I mean I'm just putting pressures on the stick and it's jumping around. This one is very tough to settle down. If I drive myself to high gains he bounces right out. I have to keep my gains very low to hold him inside. Coming up through 30. It's getting a little better now as AOA builds and the airplane becomes less responsive. Coming through 40, I'm starting to go to two hands because of the continued force required. It is requiring a lateral input as we get towards the end and there he goes. Pretty impressive, 82 alpha capability.

Setting up for repositions. Right up to about 25 AOA this is a very twitchy airplane in tracking. I couldn't even see any movement at all in the stick and yet my pipper was leaving the target in all directions. And so the pilot has to be very careful here. Okay, here's the first longitudinal reposition. Bounce, bounce, bounce, like a yo-yo. Again, it's a little bit twitchy. I'm just getting outside of that desired band. Okay, here's lateral, little better lateral, little more predictable, felt more deadbeat damped laterally. But there is constant longitudinal bouncing. I am trying to hold it steady longitudinally while I'm working lateral and he moves up and down more than 10 mils. Here's 20 alpha, the longitudinal reposition is sensitive. One small overshoot, a big undershoot and then two little overshoots and then he bounced on. It is tough to track, tough to hold inside a 10 mil circle. Coming through 25. Here comes a lateral reposition. The lateral not bad. About the same as the other airplanes. It's longitudinal I'm having trouble with. Now that we've hit 30 AOA it's getting better and more predictable. The twitchiness has gone away. Coming through 35. Now I can basically deadbeat track longitudinally. Here comes 40. Getting a little sluggish laterally but I can overdrive it still to make it happen. Here's longitudinal at 60 and not bad at 60 and we've run out at control power. That was too sensitive. I could not hold it within plus or minus 5 mils all the time. It was bouncing outside that. It just requires much too fine control out of the stick. And it is only once I get above about 30 that the response gets

sluggish enough that I can actually get a fine track. Otherwise, thought pressure on the stick is enough to make it bounce off the target.

STEM 1
PILOT F
LONGITUDINAL CONFIGURATION 194
LATERAL CONFIGURATION 33

This is what I like. This one is extremely sensitive in pitch. More so than the other one. But it's as tight as the other one. Just the slightest input causes quite a bit of motion. I wouldn't call it sloppy though. This one feels like the one before. You give a stick input, it generates a motion. The motion is about twice the magnitude of the previous flight control system but it's not sloppy. When you stop, it stops. It's just that when vou move the stick you're going to get some pipper motion for sure. I really didn't get a big chance to look at the roll. Either it's not a problem or I didn't introduce enough to make it a problem. I couldn't really check the roll except on roll in. It seems to be a little sensitive to a lateral inputs at low angle of attack. It seems laterally sensitive as well as pitch sensitive.

STEM 1
PILOT A
LONGITUDINAL CONFIGURATION 194
LATERAL CONFIGURATION 34

I'm going to buy myself a little extra time by going to higher thrust earlier so that I can stop for a while at 15 AOA and then get myself caged to this particular set of gains and then I'll let it decay. Again, I'm trying to track the centroid. A fairly big bounce out there as we get off of the non-linear stick performance. I'm in about medium burner now. Look at it bounce. Come on, settle down. It's like we're in turbulence or something. I did not want that oscillation to happen. It happened on its own. And that one, I moved the stick a fraction and off it went. And there it goes again. Again, too twitchy. I'm holding it but, boy, if he moved at all I'd just be all over the sky. I mean he's being compliant as a target could be and I'm just barely getting him. Not even half the time. This guy would make me jam my gun. Just when I think I have it right I start to take triggers and then he bounces off. Okay, we're basically steady state here at 17 alpha. Slowly decaying speed in full blower. Getting the hang of tracking him now but I still don't like it. I think I have things sorted out and then a very small pulse in the stick makes him bounce out. What I have again is a very quick longitudinal response. In the lateral axis, I seem to have a slow steady lateral oscillation like a sinusoid but longitudinal is jumping around, hard to keep that down. I can afford to put in lateral stick with reasonable amounts. But if I think about moving the longitudinal stick, he jumps out. I have to be very careful with my grip. Okay, we're approaching 20 AOA now. Very, very fine control needed on the stick for this. Lateral corrections are slow and comfortable. Longitudinal are quick and unpredictable. I could easily see myself getting into a PIO if I tried. Okay, coming through 30 alpha, he's starting to drift off slightly, back in, back in. Coming through 35, stick forces are getting fairly heavy now. Alpha is now 40. He is starting to wander out, the sensitivity is going away but so is the response. Laterally it's okay. Longitudinally it's too sensitive and I'm bouncing outside of my desired plus or minus 5 way too often and unpredictably.

It's not like he bounces out and I can put him back in and hold him there for a while. It's like he bounces out, I put him back in, he bounces out, I put him back in, and I can't really tell why he's getting off center. So if we were in any turbulence or if he was maneuvering it would be very tough.

Now I'm going for the repositions. Very, very sensitive longitudinally. Here comes longitudinal repositions. He bounced a full circle before I got it under control. Now I"m getting my gains down. Here comes lateral at 15 alpha and lateral the other way. And lateral is fine. I put in a little bit of an overdriven command, take it out and it basically stops laterally dead beat. But all the time I'm ending up with a plus or minus 10 mil or so longitudinal error. If I try and do it aggressively I cannot control the PIO very well. So I have to be very much of a lag filter in order to get him to slow down his PIO. There's a lag. I overlagged so that he stopped short and I had to walk him in. That's because of the compensation I'm putting into it. Okay, I'm backing off on the throttle a little bit to let the AOA build. Longitudinal is not real good. Just too sensitive. Here comes lateral at 20. And lateral is okay. I can get there in a second or so, but again I'm having a longitudinal problem at the same time. Coming on 25 AOA. Bounce, bounce and in. Lateral is deadbeat. But with a lot of my modification. Coming to 30. It's easier now that AOA is higher. The response is slower. Here's 35. One overshoot and then on. Now the other way. Overshoot and on. Here is 40 alpha. A little bit more sluggish laterally now. It is taking more stick movement and more stick force. Laterally I like the airplane, longitudinally I do not. Longitudinally it's too sensitive up to about 30 AOA. Hard to predict. Above 30 is the type of response that I like to see. And if we were under much more dynamic circumstances I would be incapable of tracking him for anything more than a quick hack on him.

STEM 1
PILOT F
LONGITUDINAL CONFIGURATION 194
LATERAL CONFIGURATION 34

This one is real sloppy. It is rubbery. It is just real spongy, it has a lot of slop. It has slop in the lateral axis as well. Now I am coming up in angle of attack. I am having trouble keeping him inside a 10 mil pipper. It wants to float off of him. It also seems to be a slightly sluggish pipper response to stick inputs. The pipper responds very slow to the pulls. This has about 30 mils of slop and there is a lag in the pitch axis.

STEM 1
PILOT A
LONGITUDINAL CONFIGURATION 193
LATERAL CONFIGURATION 35

Again, we have a low frequency left/right oscillation. But this one is better longitudinally. I'm not having to work nearly so hard. It's just kind of sitting there. He's inside my circle basically all the time. I'm at full blower now so I'm kind of at stable conditions as I track him around 17, 18 alpha. When I do get off of my desired it's normally left/right. Not much of a longitudinal change. Coming through 25. I'm finding this one is so nice I can feel my mind wandering as I'm doing it.

I mean I'm not having to work hard at all. I was thinking about other stuff while I'm tracking him here so that's a pretty good indicator. Coming through 30, he's staying nicely inside my pipper. Coming through 40, stick forces are getting high now. I let him get away from me a little bit there. And the controls are nice enough that I was basically tracking him up to about 72 AOA. Nice harmony, nice response.

Setting up for repositioning. I've basically changed my throttle philosophy here. I go to min blower to start and coming through about 16 AOA I go to max blower and then it stabilizes at 17-18 AOA and then I just pull it back for a minute to get to 20 and then go back to max and that gets me on the back side and I leave it at max. It seems to draw it out long enough that I have time to do an analysis. Okay, approaching 15 AOA, here's some longitudinal repositions. It's nice and quick. I was overdriving it into a PIO a little bit there. Let's do a lateral at about 15 alpha, coming over this way now, plus/minus about 5 mils the other way. Easy longitudinal. I'm still not doing it very well. Now at 16 AOA. Doing lateral corrections. One overshoot, a little bit of a lateral PIO, three oscillations, and I'm back on again. I'm holding inside the circle. Okay, let's try longitudinal at 16. He's at the top of the circle, pulling now and the bottom of the circle with one undershoot and then he's on. The other way, basically deadbeat that time. Power is coming back now to get up to 20. Okay, power is coming back in. Longitudinal is nice. I just basically smooth in a little bit of control and it gets where I want. There's 20 now. I just kind of give a little jerk on the stick and then release it and he stops. And the other way I just release the stick a little bit and then apply the aft pressure and it stops. Laterally at 20. This one is a little harder to predict laterally but that may just be a comparative thing. I'm ending up in a little bit of lateral PIO at 25 when I try and drive it. And that seems to be true all along. I think this airplane is poorer laterally than it was longitudinally, or than the other ones were and I definitely don't like the lateral as much as I like the longitudinal. Okay, here's 30 AOA. Here comes 35. Laterally, overshoot and in. Laterally the other way at 40 and in. It's now damping itself out. Now AOA is 45. I'm just going to track him two handed now. He's running away to the right. And up to about 70 again and then he's out of the circle. So that configuration was the nicest longitudinal I think. Quite a nice balance in the longitudinal. When I was doing my fine tracking I had trouble with it laterally. Whenever I missed it it was generally due to a lateral problem and that really became evident.

STEM 1
PILOT F
LONGITUDINAL CONFIGURATION 193
LATERAL CONFIGURATION 35

I'd say this configuration is tight and responsive. There's a little bit of a lateral error but this is the best of the configurations I've seen so far. This is as close as I've come tracking this guy through the entry maneuver. This control feels very responsive and very tight. It's not drifting all over the place like the other ones were.

## Data Contents for STEM 4: Dual Attack

TEST 1: Maneuver tested at $V_{min}$ using the generic fighter model

- Summary of Design Parameter Variations Tested

The following information is repeated for Analyses A, B, C, D, E, F, and G

- Numerical Summary of Statistical Analysis
- Bar Graphs of Measures of Merit
- Design Parameter Correlations, Pilot Variability, and Overall Correlations

The following information is located after Analyses A, B, C, D, E, F, and G

- Pilot Comments

Several statistical analyses are included to examine the effect of performing the manuever using loaded rolls vs. unloaded rolls and to compare the measures of merit against the first target, second target, and during the entire engagement. If only one analysis is of interest, Analysis G should be used.

| | |
|---|---|
| A, B, and C | Pilots using a loaded roll technique. |
| D, E, and F | Pilots using an unloaded roll technique. |
| A and D | Measures of merit calculated from initial time to capture of first target. |
| B and E | Measures of merit calculated from initial time to capture of second target. |
| C and F | Measures of merit calculated from capture of first target to capture of second target. |
| G | All data included. Loaded/unloaded and which time segment being analyzed are included in the SAS model. |

TEST 2: Maneuver tested at $V_c$ with the MuSIC model

- Pilot Comments

## Summary of Design Parameters Tested for STEM 4 TEST 1

Test variables:

LONDYN: Variations in a combination of longitudinal dynamics were implemented. The variations were expected to cover a range of poor and good dynamics:

(-) Poor, (CAP=0.6/$\omega_{sp}$=1.067 at 100 KEAS, ZSP=0.35 for low AOA, ZSP=0.6 for high AOA, no longitudinal stick shaping)

(+) Good, (CAP=0.6/$\omega_{sp}$=1.067, ZSP=0.7 for low AOA, ZSP=1.2 for high AOA, with longitudinal stick shaping)

AOAMAX: Indicates a maximum AOA or load factor depending on flight condition. This also indicates a variation in stick sensitivity:

(-) 40°, Aircraft can reach maximum lift but cannot reach post-stall

(+) 60°, Aircraft can be flown post-stall

LATDYN: Variations in a combination of lateral dynamics were implemented. The variations were expected to cover a range of poor and good dynamics:

(-) poor, a schedule of TR and PMAX with AOA was implemented based on MIL-STD-1797A and MCAIR high AOA research.

| AOA | TR | PMAX |
|---|---|---|
| 5° | 0.6 sec | 150.0 deg/sec |
| 15° | 1.0 sec | 100.0 deg/sec |
| 30° | 1.8 sec | 40.0 deg/sec |
| 60° | 2.1 sec | 10.0 deg/sec |

(+) good, a schedule of TR and PMAX with AOA was implemented based on MIL-STD-1797A and MCAIR high AOA research.

| AOA | TR | PMAX |
|---|---|---|
| 5° | 0.4 sec | 180.0 deg/sec |
| 15° | 0.6 sec | 150.0 deg/sec |
| 30° | 1.0 sec | 90.0 deg/sec |
| 60° | 1.6 sec | 70.0 deg/sec |

LOAD: Indicates if the maneuver was performed with loaded or unloaded rolls.

(-) Loaded rolls

(+) Unloaded rolls

TARGET: Indicates which time segment the measures of merit were calculated for.

(-) First, From initial time to capture of first target.

(+) Second, From initial time to capture of second target.

(++) First to Second, From capture of first target to capture of second target.

**Summary of Design Parameters Tested for STEM 4 TEST 1**

**Test Matrix for Analyses A, B, C, D, E, and F (Pilots E,G)**

| Lon Config | Lat Config | LONDYN | AOAMAX | LATDYN |
|---|---|---|---|---|
| 101 | 11 | Poor (-) | 40° (-) | Good (+) |
| 126 | 20 | Good (+) | 40° (-) | Poor (-) |
| 119 | 20 | Poor (-) | 60° (+) | Poor (-) |
| 120 | 11 | Good (+) | 60° (+) | Good (+) |

**Test Matrix for Analysis G (Pilots E,G)**

| Lon Config | Lat Config | LONDYN | AOAMAX | LATDYN | LOAD | TARGET |
|---|---|---|---|---|---|---|
| 101 | 11 | Poor (-) | 40° (-) | Good (+) | Both | All |
| 126 | 20 | Good (+) | 40° (-) | Poor (-) | Both | All |
| 119 | 20 | Poor (-) | 60° (+) | Poor (-) | Both | All |
| 120 | 11 | Good (+) | 60° (+) | Good (+) | Both | All |

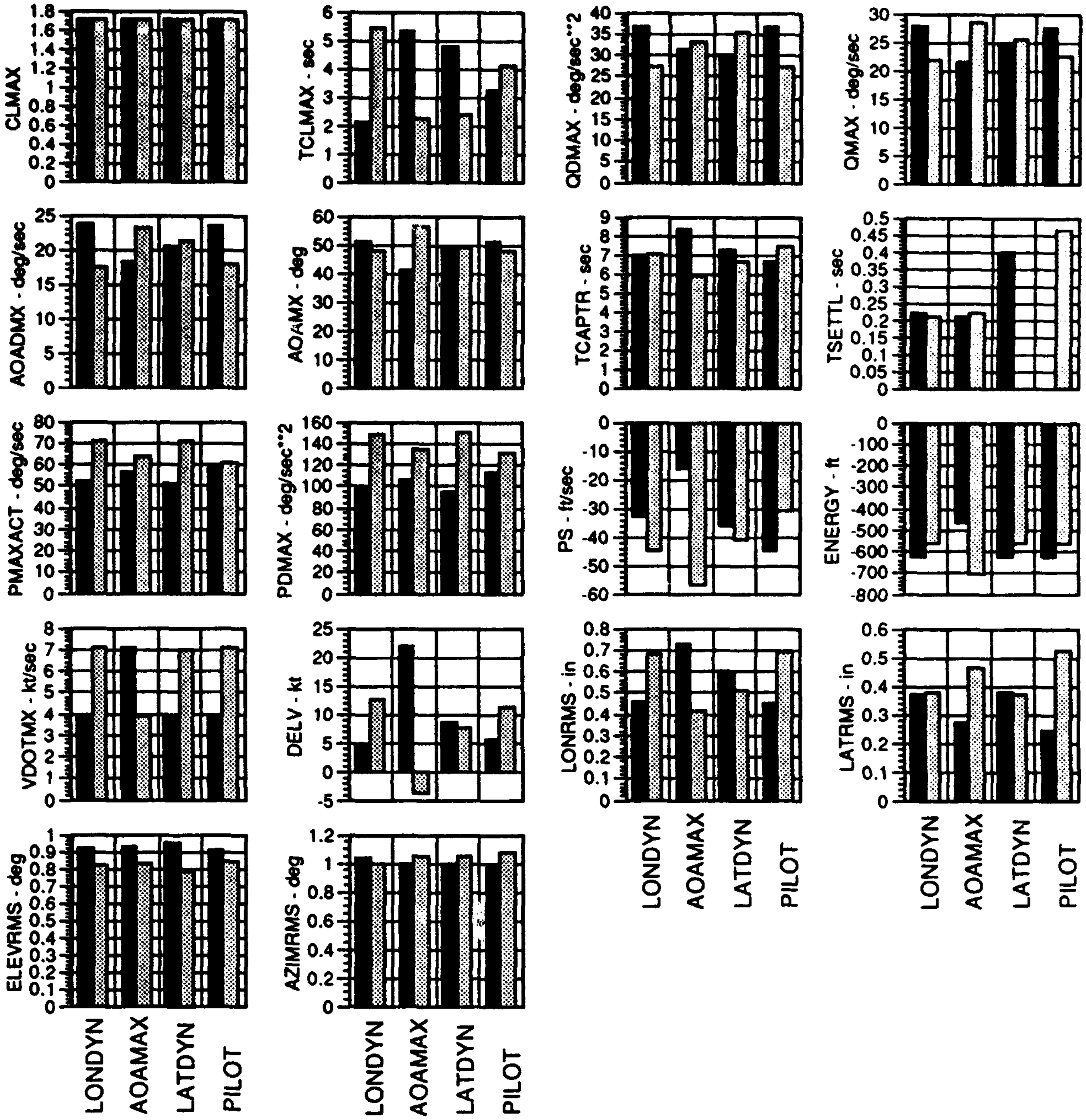
STEM 4 TEST 1 ANALYSIS A

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | CLMAX | 0.4756 | LONDYN | 0.336 | 1.719 | 1.7187 | 0 | 0 | 0.000 | 0.29 | 4 | 3 | 4 |
| | | | AOAMAX | 0.046 | 1.7188 | 1.7188 | 0 | 0 | 0.000 | 0.06 | 4 | 3 | 4 |
| | | | LATDYN | 0.932 | 1.7182 | 1.7195 | 0 | 0 | 0.001 | 1.23 | 4 | 2 | 4 |
| | | | PLT | 0.839 | 1.7183 | 1.7194 | 0 | 0 | 0.001 | | | | |
| 3 | TCLMAX | 0.9999 | LONDYN | 1.000 | 2.1144 | 5.4461 | 0 | 0 | 1.094 | 4.50 | 1 | 1 | 1 |
| | | | AOAMAX | 1.000 | 5.3273 | 2.2163 | 0 | 0 | -0.994 | 4.09 | 1 | 1 | 1 |
| | | | LATDYN | 1.000 | 4.7498 | 2.3715 | 0 | 0 | -0.752 | 3.09 | 1 | 1 | 1 |
| | | | PLT | 1.000 | 3.2443 | 4.128 | 0 | 0 | 0.243 | | | | |
| 6 | QDMAX | 0.9999 | LONDYN | 0.999 | 36.575 | 27.6 | 0 | 0 | -0.285 | 0.93 | 2 | 3 | 4 |
| | | | AOAMAX | 0.402 | 31.462 | 33.265 | 0 | 0 | 0.056 | 0.18 | 4 | 3 | 4 |
| | | | LATDYN | 0.990 | 29.896 | 35.392 | 0 | 0 | 0.170 | 0.55 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 36.889 | 27.233 | 0 | 0 | -0.308 | | | | |
| 8 | QMAX | 0.9999 | LONDYN | 1.000 | 28.003 | 22.031 | 0 | 0 | -0.242 | 1.20 | 2 | 2 | 3 |
| | | | AOAMAX | 1.000 | 21.488 | 28.469 | 0 | 0 | 0.285 | 1.41 | 2 | 2 | 3 |
| | | | LATDYN | 0.952 | 24.877 | 25.678 | 0 | 0 | 0.032 | 0.16 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 27.557 | 22.552 | 0 | 0 | -0.202 | | | | |
| 11 | AOADMX | 0.9999 | LONDYN | 1.000 | 23.735 | 17.528 | 0 | 0 | -0.308 | 1.15 | 2 | 2 | 3 |
| | | | AOAMAX | 1.000 | 18.12 | 23.228 | 0 | 0 | 0.251 | 0.93 | 2 | 3 | 4 |
| | | | LATDYN | 0.923 | 20.471 | 21.337 | 0 | 0 | 0.041 | 0.15 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 23.387 | 17.934 | 0 | 0 | -0.269 | | | | |
| 20 | AOAMX | 0.9999 | LONDYN | 1.000 | 50.966 | 47.602 | 0 | 0 | -0.068 | 1.09 | 4 | 2 | 4 |
| | | | AOAMAX | 1.000 | 41.383 | 56.297 | 0 | 0 | 0.313 | 4.97 | 2 | 1 | 2 |
| | | | LATDYN | 0.993 | 49.414 | 49.412 | 0 | 0 | 0.000 | 0.00 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 50.844 | 47.744 | 0 | 0 | -0.063 | | | | |
| 25 | TCAPTR | 0.9999 | LONDYN | 0.092 | 7.0001 | 7.0336 | 0 | 0 | 0.005 | 0.04 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 8.3315 | 5.8877 | 0 | 0 | -0.354 | 2.92 | 2 | 1 | 2 |
| | | | LATDYN | 0.987 | 7.3034 | 6.6798 | 0 | 0 | -0.089 | 0.74 | 4 | 3 | 4 |
| | | | PLT | 0.981 | 6.6228 | 7.4738 | 0 | 0 | 0.121 | | | | |
| 26 | TSETTL | 0.8501 | LONDYN | 0.034 | 0.2179 | 0.2083 | 0 | 0 | -0.045 | | 4 | | |
| | | | AOAMAX | 0.031 | 0.2083 | 0.2179 | 0 | 0 | 0.045 | | 4 | | |
| | | | LATDYN | 0.910 | 0.3964 | 0 | 0 | 0 | 0.000 | | 4 | | |
| | | | PLT | 0.960 | 0 | 0.4625 | 0 | 0 | 0.000 | | | | |
| 30 | PMAXACT | 0.9994 | LONDYN | 1.000 | 51.677 | 70.402 | 0 | 0 | 0.314 | 11.72 | 2 | 1 | 2 |
| | | | AOAMAX | 0.933 | 56.386 | 63.69 | 0 | 0 | 0.122 | 4.55 | 3 | 1 | 3 |
| | | | LATDYN | 0.999 | 51.417 | 70.705 | 0 | 0 | 0.324 | 12.08 | 2 | 1 | 2 |
| | | | PLT | 0.054 | 59.572 | 61.191 | 0 | 0 | 0.027 | | | | |
| 32 | PDMAX | 0.9999 | LONDYN | 1.000 | 96.344 | 149.25 | 0 | 0 | 0.452 | 3.12 | 1 | 1 | 1 |
| | | | AOAMAX | 0.996 | 105.57 | 133.79 | 0 | 0 | 0.239 | 1.65 | 2 | 2 | 3 |
| | | | LATDYN | 1.000 | 95.25 | 150.53 | 0 | 0 | 0.474 | 3.28 | 1 | 1 | 1 |
| | | | PLT | 0.787 | 112.7 | 130.17 | 0 | 0 | 0.145 | | | | |
| 36 | PS | 0.9999 | LONDYN | 0.943 | -32.704 | -44.761 | 0 | 0 | -0.319 | 0.84 | 2 | 3 | 4 |
| | | | AOAMAX | 1.000 | -16.57 | -56.867 | 0 | 0 | -1.570 | 4.12 | 1 | 1 | 1 |
| | | | LATDYN | 0.735 | -36.008 | -40.906 | 0 | 0 | -0.128 | 0.34 | 4 | 3 | 4 |
| | | | PLT | 0.951 | -44.683 | -30.785 | 0 | 0 | 0.381 | | | | |
| 37 | ENERGY | 0.9999 | LONDYN | 0.993 | -627.25 | -560.49 | 0 | 0 | 0.113 | 1.11 | 3 | 2 | 4 |
| | | | AOAMAX | 1.000 | -466.28 | -708 | 0 | 0 | -0.430 | 4.25 | 1 | 1 | 1 |
| | | | LATDYN | 0.947 | -626.8 | -561.01 | 0 | 0 | 0.111 | 1.10 | 3 | 2 | 4 |
| | | | PLT | 0.890 | -624.1 | -564.16 | 0 | 0 | 0.101 | | | | |
| 38 | VDOTMX | 0.9822 | LONDYN | 0.959 | 3.872 | 7.062 | 0 | 0 | 0.638 | 0.98 | 1 | 3 | 3 |
| | | | AOAMAX | 0.948 | 7.09 | 3.848 | 0 | 0 | -0.650 | 0.99 | 1 | 3 | 3 |
| | | | LATDYN | 0.921 | 3.9048 | 7.0238 | 0 | 0 | 0.621 | 0.95 | 1 | 3 | 3 |
| | | | PLT | 0.918 | 3.841 | 7.0982 | 0 | 0 | 0.653 | | | | |
| 39 | DELV | 0.9999 | LONDYN | 1.000 | 4.4238 | 12.47 | 0 | [illegible] | 1.232 | 1.58 | 1 | 2 | 2 |
| | | | AOAMAX | 1.000 | 21.89 | -3.6507 | 0 | 0 | -4.081 | 5.24 | 1 | 1 | 1 |
| | | | LATDYN | [illegible] | 8.6901 | 7.4927 | 0 | 0 | -0.149 | 0.19 | 3 | 3 | 4 |
| | | | PLT | 0.995 | 5.4879 | 11.229 | 0 | 0 | 0.779 | | | | |

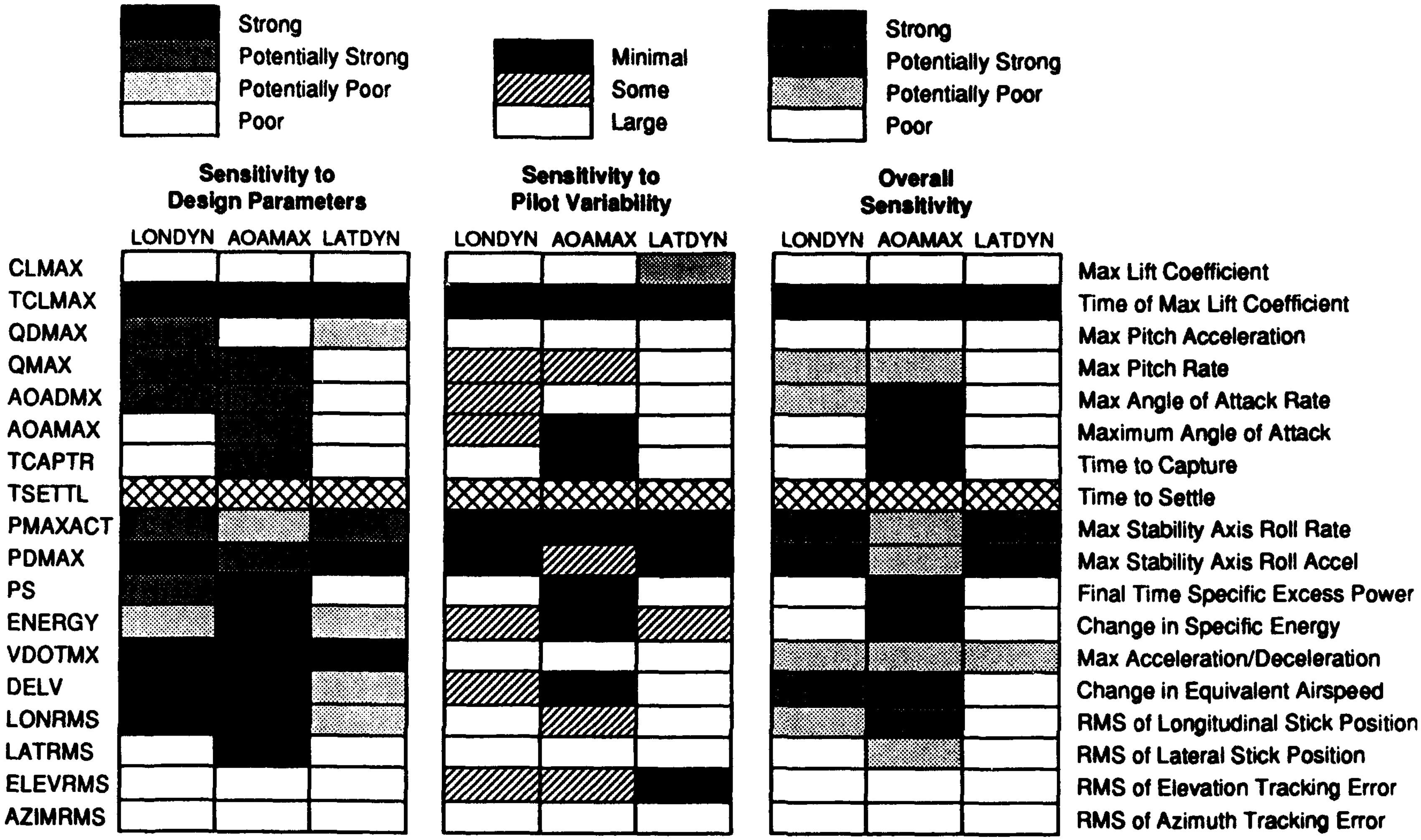
STEM 4 TEST 1 ANALYSIS A

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 42 | LONRMS | 0.9996 | LONDYN | 0.997 | 0.4549 | 0.6823 | 0 | 0 | 0.417 | 0.92 | 1 | 3 | 3 |
| | | | AOAMAX | 1.000 | 0.7293 | 0.4146 | 0 | 0 | -0.5[illegible]5 | 1.31 | 1 | 2 | 2 |
| | | | LATDYN | 0.934 | 0.6039 | 0.5085 | 0 | 0 | -0.173 | 0.38 | 3 | 3 | 4 |
| | | | PLT | 0.996 | 0.446 | 0.6926 | 0 | 0 | 0.455 | | | | |
| 43 | LATRMS | 0.9273 | LONDYN | 0.038 | 0.3726 | 0.3768 | 0 | 0 | 0.011 | 0.01 | 4 | 3 | 4 |
| | | | AOAMAX | 0.957 | 0.2721 | 0.4623 | 0 | 0 | 0.555 | 0.66 | 1 | 3 | 3 |
| | | | LATDYN | 0.103 | 0.3749 | 0.3741 | 0 | 0 | -0.002 | 0.00 | 4 | 3 | 4 |
| | | | PLT | 0.996 | 0.2454 | 0.5252 | 0 | 0 | 0.837 | | | | |
| 44 | ELEVRMS | 0.5336 | LONDYN | 0.559 | 0.9139 | 0.822 | 0 | 0 | -0.106 | 1.36 | 4 | 2 | 4 |
| | | | AOAMAX | 0.642 | 0.9271 | 0.8239 | 0 | 0 | -0.118 | 1.52 | 4 | 2 | 4 |
| | | | LATDYN | 0.835 | 0.9487 | 0.7814 | 0 | 0 | -0.195 | 2.50 | 4 | 1 | 4 |
| | | | PLT | 0.377 | 0.9028 | 0.835 | 0 | 0 | -0.078 | | | | |
| 45 | AZIMRMS | 0.4542 | LONDYN | 0.182 | 1.0378 | 1.0011 | 0 | 0 | -0.036 | 0.34 | 4 | 3 | 4 |
| | | | AOAMAX | 0.248 | 0.9924 | 1.0452 | 0 | 0 | 0.052 | 0.49 | 4 | 3 | 4 |
| | | | LATDYN | 0.268 | 0.9985 | 1.0469 | 0 | 0 | 0.047 | 0.44 | 4 | 3 | 4 |
| | | | PLT | 0.516 | 0.9706 | 1.0795 | 0 | 0 | 0.107 | | | | |

STEM 4 TEST 1 ANALYSIS A



## STEM 4 TEST 1 ANALYSIS A

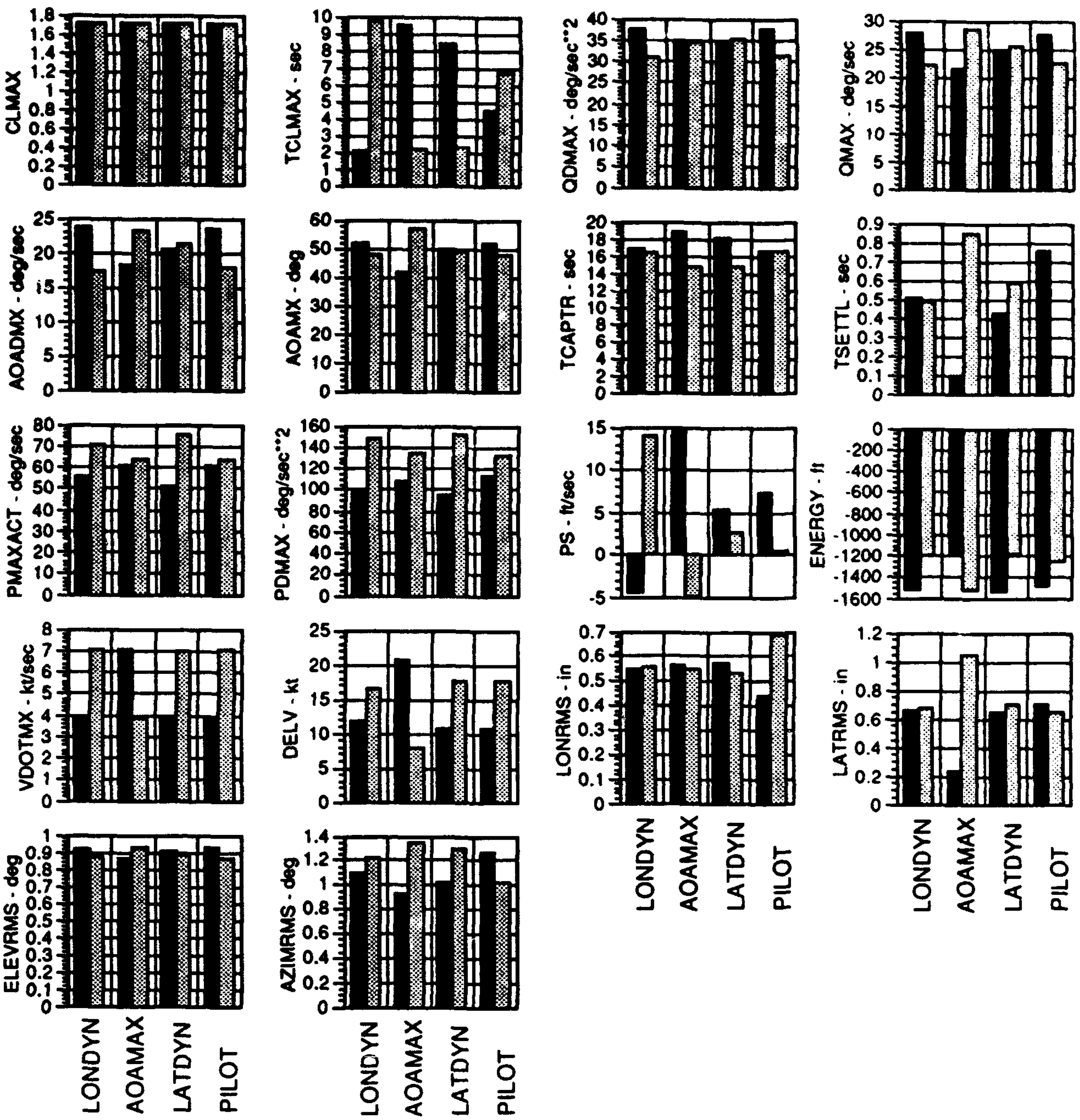


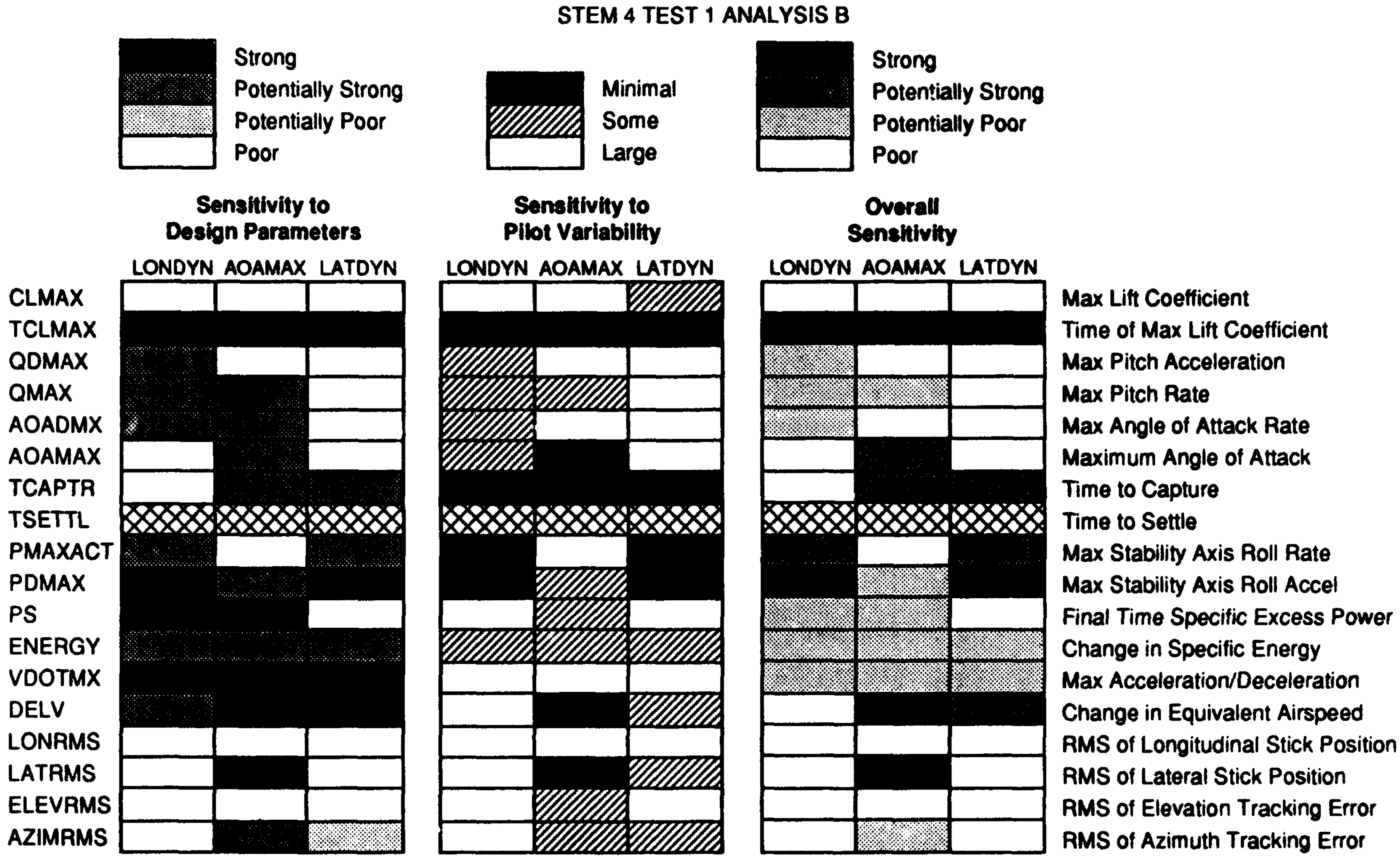
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | CLMAX | 0.2497 | LONDYN | 0.123 | 1.719 | 1.7191 | 0 | 0 | 0.000 | 0.12 | 4 | 3 | 4 |
| | | | AOAMAX | 0.374 | 1.7192 | 1.7188 | 0 | 0 | 0.000 | 0.37 | 4 | 3 | 4 |
| | | | LATDYN | 0.801 | 1.7186 | 1.7196 | 0 | 0 | 0.001 | 1.00 | 4 | 2 | 4 |
| | | | PLT | 0.781 | 1.7186 | 1.7195 | 0 | 0 | 0.001 | | | | |
| 3 | TCLMAX | 0.9999 | LONDYN | 1.000 | 2.0776 | 9.6897 | 0 | 0 | 2.225 | 5.48 | 1 | 1 | 1 |
| | | | AOAMAX | 1.000 | 9.5423 | 2.2039 | 0 | 0 | -2.049 | 5.05 | 1 | 1 | 1 |
| | | | LATDYN | 1.000 | 8.3833 | 2.333 | 0 | 0 | -1.658 | 4.08 | 1 | 1 | 1 |
| | | | PLT | 0.935 | 4.5682 | 6.784 | 0 | 0 | 0.406 | | | | |
| 6 | QDMAX | 0.9757 | LONDYN | 0.956 | 37.798 | 30.838 | 0 | 0 | -0.205 | 1.14 | 2 | 2 | 3 |
| | | | AOAMAX | 0.172 | 34.7 | 34.489 | 0 | 0 | -0.006 | 0.03 | 4 | 3 | 4 |
| | | | LATDYN | 0.449 | 33.895 | 35.392 | 0 | 0 | 0.043 | 0.24 | 4 | 3 | 4 |
| | | | PLT | 0.913 | 37.409 | 31.292 | 0 | 0 | -0.179 | | | | |
| 8 | QMAX | 0.9999 | LONDYN | 1.000 | 28.003 | 22.133 | 0 | 0 | -0.237 | 1.20 | 2 | 2 | 3 |
| | | | AOAMAX | 1.000 | 21.59 | 28.469 | 0 | 0 | 0.280 | 1.42 | 2 | 2 | 3 |
| | | | LATDYN | 0.935 | 24.964 | 25.678 | 0 | 0 | 0.028 | 0.14 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 27.557 | 22.654 | 0 | 0 | -0.197 | | | | |
| 11 | AOADMX | 0.9999 | LONDYN | 1.000 | 23.735 | 17.528 | 0 | 0 | -0.308 | 1.15 | 2 | 2 | 3 |
| | | | AOAMAX | 1.000 | 18.12 | 23.228 | 0 | 0 | 0.251 | 0.93 | 2 | 3 | 4 |
| | | | LATDYN | 0.923 | 20.471 | 21.337 | 0 | 0 | 0.041 | 0.15 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 23.387 | 17.934 | 0 | 0 | -0.269 | | | | |
| 20 | AOAMX | 0.9999 | LONDYN | 1.000 | 51.572 | 47.652 | 0 | 0 | -0.079 | 1.05 | 4 | 2 | 4 |
| | | | AOAMAX | 1.000 | 41.432 | 56.903 | 0 | 0 | 0.323 | 4.30 | 2 | 1 | 2 |
| | | | LATDYN | 0.960 | 50.063 | 49.412 | 0 | 0 | -0.013 | 0.17 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 51.479 | 47.761 | 0 | 0 | -0.075 | | | | |
| 25 | TCAPTR | 0.9998 | LONDYN | 0.419 | 16.781 | 16.373 | 0 | 0 | -0.025 | 3.13 | 4 | 1 | 4 |
| | | | AOAMAX | 1.000 | 18.713 | 14.775 | 0 | 0 | -0.238 | 30.28 | 2 | 1 | 2 |
| | | | LATDYN | 1.000 | 18.176 | 14.746 | 0 | 0 | -0.211 | 26.76 | 2 | 1 | 2 |
| | | | PLT | 0.135 | 16.533 | 16.663 | 0 | 0 | 0.008 | | | | |
| 26 | TSETTL | 0.3265 | LONDYN | 0.029 | 0.5071 | 0.4875 | 0 | 0 | -0.040 | 0.02 | 4 | 3 | 4 |
| | | | AOAMAX | 0.827 | 0.0958 | 0.8429 | 0 | 0 | 4.341 | 2.41 | 2 | 1 | 2 |
| | | | LATDYN | 0.306 | 0.425 | 0.5833 | 0 | 0 | 0.322 | 0.18 | 4 | 3 | 4 |
| | | | PLT | 0.670 | 0.7571 | 0.1958 | 0 | 0 | -1.804 | | | | |
| 30 | PMAXACT | 0.9999 | LONDYN | 1.000 | 55.562 | 70.402 | 0 | 0 | 0.239 | 5.09 | 2 | 1 | 2 |
| | | | AOAMAX | 0.732 | 60.919 | 63.69 | 0 | 0 | 0.045 | 0.95 | 4 | 3 | 4 |
| | | | LATDYN | 1.000 | 51.417 | 75.237 | 0 | 0 | 0.390 | 8.31 | 2 | 1 | 2 |
| | | | PLT | 0.161 | 61.057 | 63.99 | 0 | 0 | 0.047 | | | | |
| 32 | PDMAX | 0.9999 | LONDYN | 1.000 | 97.731 | 149.25 | 0 | 0 | 0.436 | 2.78 | 1 | 1 | 1 |
| | | | AOAMAX | 0.997 | 107.19 | 133.79 | 0 | 0 | 0.223 | 1.42 | 2 | 2 | 3 |
| | | | LATDYN | 1.000 | 95.25 | 152.14 | 0 | 0 | 0.486 | 3.09 | 1 | 1 | 1 |
| | | | PLT | 0.867 | 112.7 | 131.79 | 0 | 0 | 0.157 | | | | |
| 36 | PS | 0.8032 | LONDYN | 0.931 | -4.3494 | 14.016 | 0 | 0 | 2.766 | 0.33 | 1 | 3 | 3 |
| | | | AOAMAX | 0.928 | 14.573 | -4.827 | 0 | 0 | -2.675 | 0.32 | 1 | 3 | 3 |
| | | | LATDYN | 0.401 | 5.2985 | 2.7599 | 0 | 0 | -0.699 | 0.08 | 4 | 3 | 4 |
| | | | PLT | 0.652 | 7.296 | 0.4294 | 0 | 0 | -8.465 | | | | |
| 37 | ENERGY | 0.9999 | LONDYN | 1.000 | -1524.2 | -1203 | 0 | 0 | 0.239 | 1.34 | 2 | 2 | 3 |
| | | | AOAMAX | 1.000 | -1201.4 | -1525.5 | 0 | 0 | -0.241 | 1.36 | 2 | 2 | 3 |
| | | | LATDYN | 1.000 | -1538.3 | -1186.4 | 0 | 0 | 0.263 | 1.48 | 2 | 2 | 3 |
| | | | PLT | 0.998 | -1487.2 | -1246.1 | 0 | 0 | 0.178 | | | | |
| 38 | VDOTMX | 0.9822 | LONDYN | 0.959 | 3.872 | 7.062 | 0 | 0 | 0.638 | 0.98 | 1 | 3 | 3 |
| | | | AOAMAX | 0.948 | 7.09 | 3.848 | 0 | 0 | -0.650 | 0.99 | 1 | 3 | 3 |
| | | | LATDYN | 0.921 | 3.9048 | 7.0238 | 0 | 0 | 0.621 | 0.95 | 1 | 3 | 3 |
| | | | PLT | 0.918 | 3.841 | 7.0982 | 0 | 0 | 0.653 | | | | |
| 39 | DELV | 0.9995 | LONDYN | 0.949 | 11.714 | 16.545 | 0 | 0 | 0.352 | 0.69 | 2 | 3 | 4 |
| | | | AOAMAX | 1.000 | 20.849 | 8.0251 | 0 | 0 | -1.107 | 2.18 | 1 | 1 | 1 |
| | | | LATDYN | 0.981 | 10.666 | 17.768 | 0 | 0 | 0.533 | 1.05 | 1 | 2 | 2 |
| | | | PLT | 0.966 | 10.805 | 17.606 | 0 | 0 | 0.508 | | | | |

STEM 4 TEST 1 ANALYSIS B

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 42 | LONRMS | 0.946 | LONDYN | 0.063 | 0.5518 | 0.5574 | 0 | 0 | 0.010 | 0.02 | 4 | 3 | 4 |
| | | | AOAMAX | 0.180 | 0.5633 | 0.5468 | 0 | 0 | -0.030 | 0.06 | 4 | 3 | 4 |
| | | | LATDYN | 0.413 | 0.5716 | 0.5344 | 0 | 0 | -0.067 | 0.14 | 4 | 3 | 4 |
| | | | PLT | 0.998 | 0.4372 | 0.6911 | 0 | 0 | 0.474 | | | | |
| 43 | LATRMS | 0.9993 | LONDYN | 0.089 | 0.6651 | 0.6796 | 0 | 0 | 0.022 | 0.27 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 0.2331 | 1.0477 | 0 | 0 | 2.136 | 26.98 | 1 | 1 | 1 |
| | | | LATDYN | 0.619 | 0.6434 | 0.7048 | 0 | 0 | 0.091 | 1.15 | 4 | 2 | 4 |
| | | | PLT | 0.042 | 0.6962 | 0.6433 | 0 | 0 | -0.079 | | | | |
| 44 | ELEVRMS | 0.4425 | LONDYN | 0.330 | 0.9147 | 0.8757 | 0 | 0 | -0.044 | 0.59 | 4 | 3 | 4 |
| | | | AOAMAX | 0.535 | 0.859 | 0.9289 | 0 | 0 | 0.078 | 1.06 | 4 | 2 | 4 |
| | | | LATDYN | 0.152 | 0.9081 | 0.8834 | 0 | 0 | -0.028 | 0.37 | 4 | 3 | 4 |
| | | | PLT | 0.473 | 0.9271 | 0.8611 | 0 | 0 | -0.074 | | | | |
| 45 | AZIMRMS | 0.8871 | LONDYN | 0.494 | 1.0996 | 1.2181 | 0 | 0 | 0.103 | 0.47 | 4 | 3 | 4 |
| | | | AOAMAX | 0.977 | 0.9258 | 1.3502 | 0 | 0 | 0.386 | 1.76 | 2 | 2 | 3 |
| | | | LATDYN | 0.895 | 1.0269 | 1.303 | 0 | 0 | 0.240 | 1.10 | 3 | 2 | 4 |
| | | | PLT | 0.827 | 1.2688 | 1.0207 | 0 | 0 | -0.219 | | | | |

STEM 4 TEST 1 ANALYSIS B





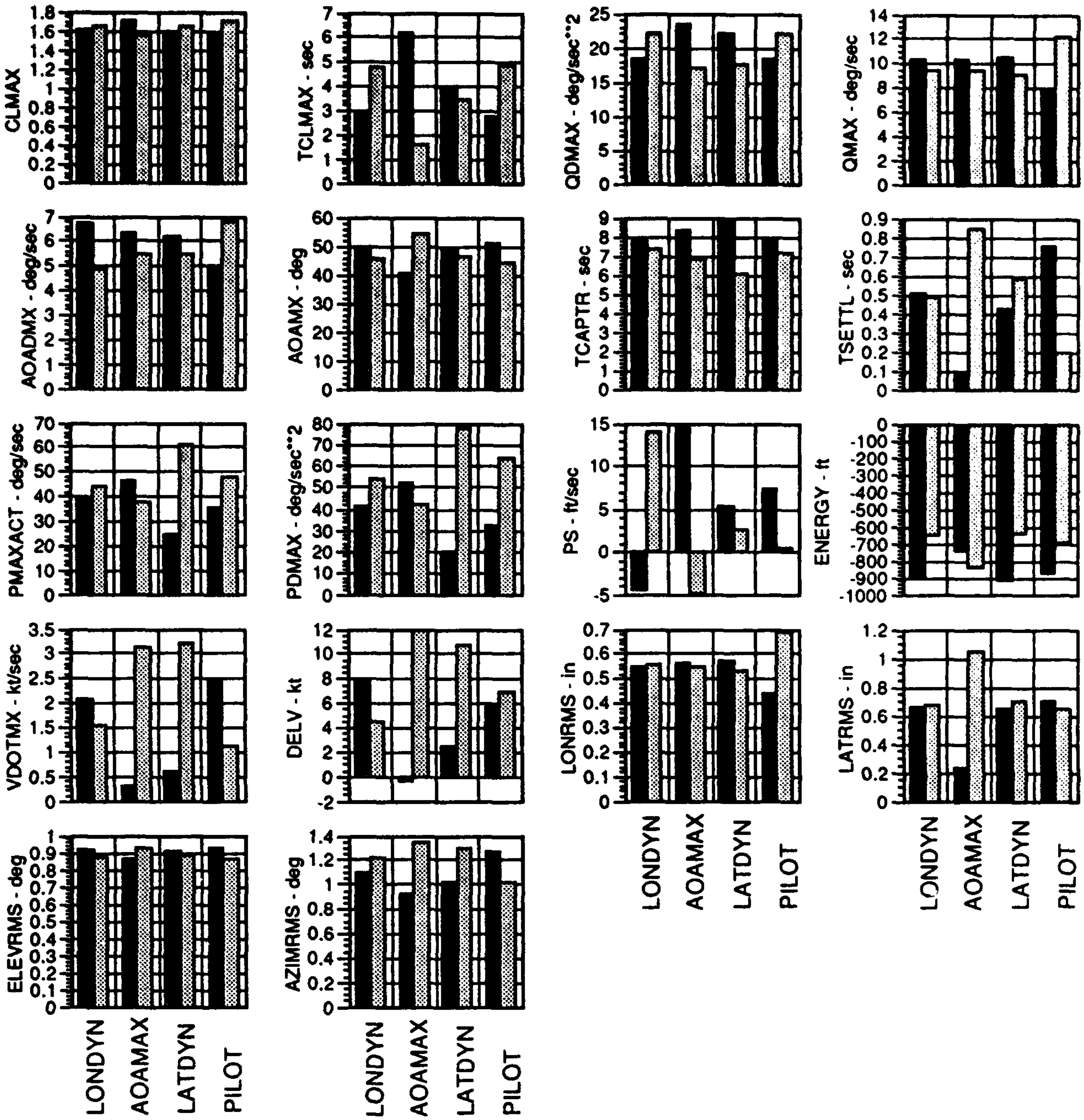
STEM 4 TEST 1 ANALYSIS B
Strong
Potentially Strong
Potentially Poor
Poor
Minimal
Some
Large
Strong
Potentially Strong
Potentially Poor
Poor
Sensitivity to Design Parameters
Sensitivity to Pilot Variability
Overall Sensitivity
LONDYN AOAMAX LATDYN
LONDYN AOAMAX LATDYN
LONDYN AOAMAX LATDYN
CLMAX
TCLMAX
QDMAX
QMAX
AOADMX
AOAMAX
TCAPTR
TSETTL
PMAXACT
PDMAX
PS
ENERGY
VDOTMX
DELV
LONRMS
LATRMS
ELEVRMS
AZIMRMS
Max Lift Coefficient
Time of Max Lift Coefficient
Max Pitch Acceleration
Max Pitch Rate
Max Angle of Attack Rate
Maximum Angle of Attack
Time to Capture
Time to Settle
Max Stability Axis Roll Rate
Max Stability Axis Roll Accel
Final Time Specific Excess Power
Change in Specific Energy
Max Acceleration/Deceleration
Change in Equivalent Airspeed
RMS of Longitudinal Stick Position
RMS of Lateral Stick Position
RMS of Elevation Tracking Error
RMS of Azimuth Tracking Error

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | CLMAX | 0.9999 | LONDYN | 0.994 | 1.6032 | 1.6564 | 0 | 0 | 0.033 | 0.31 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 1.7198 | 1.5489 | 0 | 0 | -0.105 | 0.99 | 3 | 3 | 4 |
| | | | LATDYN | 0.973 | 1.602 | 1.6578 | 0 | 0 | 0.034 | 0.32 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 1.5484 | 1.7204 | 0 | 0 | 0.106 | | | | |
| 3 | TCLMAX | 0.9999 | LONDYN | 0.999 | 2.837 | 4.7852 | 0 | 0 | 0.547 | 0.92 | 1 | 3 | 3 |
| | | | AOAMAX | 1.000 | 6.1816 | 1.6401 | 0 | 0 | -1.752 | 2.95 | 1 | 1 | 1 |
| | | | LATDYN | 0.939 | 3.9789 | 3.4531 | 0 | 0 | -0.142 | 0.24 | 3 | 3 | 4 |
| | | | PLT | 0.998 | 2.7704 | 4.863 | 0 | 0 | 0.593 | | | | |
| 6 | QDMAX | 0.8295 | LONDYN | 0.736 | 18.424 | 22.111 | 0 | 0 | 0.183 | 1.02 | 4 | 2 | 4 |
| | | | AOAMAX | 0.928 | 23.544 | 17.196 | 0 | 0 | -0.319 | 1.78 | 2 | 2 | 3 |
| | | | LATDYN | 0.866 | 22.12 | 17.799 | 0 | 0 | -0.219 | 1.22 | 3 | 2 | 4 |
| | | | PLT | 0.680 | 18.462 | 22.067 | 0 | 0 | 0.179 | | | | |
| 8 | QMAX | 0.9994 | LONDYN | 0.701 | 10.318 | 9.4266 | 0 | 0 | -0.090 | 0.20 | 4 | 3 | 4 |
| | | | AOAMAX | 0.760 | 10.415 | 9.4704 | 0 | 0 | -0.095 | 0.21 | 4 | 3 | 4 |
| | | | LATDYN | 0.907 | 10.583 | 9.1167 | 0 | 0 | -0.150 | 0.33 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 7.8855 | 12.264 | 0 | 0 | 0.456 | | | | |
| 11 | AOADMX | 0.9184 | LONDYN | 0.942 | 6.7182 | 4.8525 | 0 | 0 | -0.331 | 1.10 | 2 | 2 | 3 |
| | | | AOAMAX | 0.706 | 6.3211 | 5.4594 | 0 | 0 | -0.147 | 0.49 | 4 | 3 | 4 |
| | | | LATDYN | 0.525 | 6.1969 | 5.4607 | 0 | 0 | -0.127 | 0.42 | 4 | 3 | 4 |
| | | | PLT | 0.942 | 5.052 | 6.7964 | 0 | 0 | 0.301 | | | | |
| 20 | AOAMX | 0.9999 | LONDYN | 1.000 | 49.554 | 45.885 | 0 | 0 | -0.077 | 0.58 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 40.23 | 54.401 | 0 | 0 | 0.306 | 2.30 | 2 | 1 | 2 |
| | | | LATDYN | 1.000 | 49.041 | 46.483 | 0 | 0 | -0.054 | 0.40 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 50.774 | 44.46 | 0 | 0 | -0.133 | | | | |
| 25 | TCAPTR | 0.9966 | LONDYN | 0.549 | 7.7977 | 7.3394 | 0 | 0 | -0.061 | 0.65 | 4 | 3 | 4 |
| | | | AOAMAX | 0.980 | 8.3816 | 6.9044 | 0 | 0 | -0.195 | 2.10 | 3 | 1 | 3 |
| | | | LATDYN | 1.000 | 8.8896 | 6.0656 | 0 | 0 | -0.392 | 4.22 | 2 | 1 | 2 |
| | | | PLT | 0.667 | 7.9096 | 7.2088 | 0 | 0 | -0.093 | | | | |
| 26 | TSETTL | 0.3265 | LONDYN | 0.029 | 0.5071 | 0.4875 | 0 | 0 | -0.040 | 0.02 | 4 | 3 | 4 |
| | | | AOAMAX | 0.827 | 0.0958 | 0.8429 | 0 | 0 | 4.341 | 2.41 | 2 | 1 | 2 |
| | | | LATDYN | 0.306 | 0.425 | 0.5833 | 0 | 0 | 0.322 | 0.18 | 4 | 3 | 4 |
| | | | PLT | 0.670 | 0.7571 | 0.1958 | 0 | 0 | -1.804 | | | | |
| 30 | PMAXACT | 0.9999 | LONDYN | 0.992 | 39.615 | 43.669 | 0 | 0 | 0.098 | 0.32 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 46.212 | 37.435 | 0 | 0 | -0.212 | 0.69 | 2 | 3 | 4 |
| | | | LATDYN | 1.000 | 24.664 | 61.112 | 0 | 0 | 1.037 | 3.40 | 1 | 1 | 1 |
| | | | PLT | 1.000 | 35.701 | 48.235 | 0 | 0 | 0.305 | | | | |
| 32 | PDMAX | 0.9999 | LONDYN | 0.993 | 41.016 | 53.932 | 0 | 0 | 0.277 | 0.40 | 2 | 3 | 4 |
| | | | AOAMAX | 0.932 | 51.924 | 42.738 | 0 | 0 | -0.196 | 0.28 | 3 | 3 | 4 |
| | | | LATDYN | 1.000 | 20.225 | 78.189 | 0 | 0 | 1.804 | 2.58 | 1 | 1 | 1 |
| | | | PLT | 1.000 | 32.963 | 63.328 | 0 | 0 | 0.700 | | | | |
| 36 | PS | 0.8032 | LONDYN | 0.931 | -4.3494 | 14.016 | 0 | 0 | 2.766 | 0.33 | 1 | 3 | 3 |
| | | | AOAMAX | 0.928 | 14.573 | -4.827 | 0 | 0 | -2.675 | 0.32 | 1 | 3 | 3 |
| | | | LATDYN | 0.401 | 5.2985 | 2.7599 | 0 | 0 | -0.699 | 0.08 | 4 | 3 | 4 |
| | | | PLT | 0.652 | 7.296 | 0.4294 | 0 | 0 | -8.465 | | | | |
| 37 | ENERGY | 0.9999 | LONDYN | 1.000 | -903.89 | -651.33 | 0 | 0 | 0.334 | 1.40 | 2 | 2 | 3 |
| | | | AOAMAX | 0.971 | -733.79 | -833.21 | 0 | 0 | -0.127 | 0.53 | 3 | 3 | 4 |
| | | | LATDYN | 1.000 | -919.45 | -633.17 | 0 | 0 | 0.382 | 1.60 | 2 | 2 | 3 |
| | | | PLT | 1.000 | -872.07 | -688.45 | 0 | 0 | 0.239 | | | | |
| 38 | VDOTMX | 0.8765 | LONDYN | 0.296 | 2.0689 | 1.5334 | 0 | 0 | -0.304 | 0.35 | 4 | 3 | 4 |
| | | | AOAMAX | 0.939 | 0.3073 | 3.1199 | 0 | 0 | 5.027 | 5.77 | 1 | 1 | 1 |
| | | | LATDYN | 0.944 | 0.6215 | 3.2221 | 0 | 0 | 2.496 | 2.86 | 1 | 1 | 1 |
| | | | PLT | 0.634 | 2.434 | 1.1075 | 0 | 0 | -0.871 | | | | |
| 39 | DELV | 0.9998 | LONDYN | 0.853 | 7.8982 | 4.4185 | 0 | 0 | -0.614 | 3.10 | 2 | 1 | 2 |
| | | | AOAMAX | 1.000 | -0.3537 | 11.989 | 0 | 0 | 17.961 | 90.69 | 1 | 1 | 1 |
| | | | LATDYN | 0.999 | 2.5293 | 10.682 | 0 | 0 | 1.993 | 10.06 | 1 | 1 | 1 |
| | | | PLT | 0.540 | 5.7182 | 6.9618 | 0 | 0 | 0.198 | | | | |

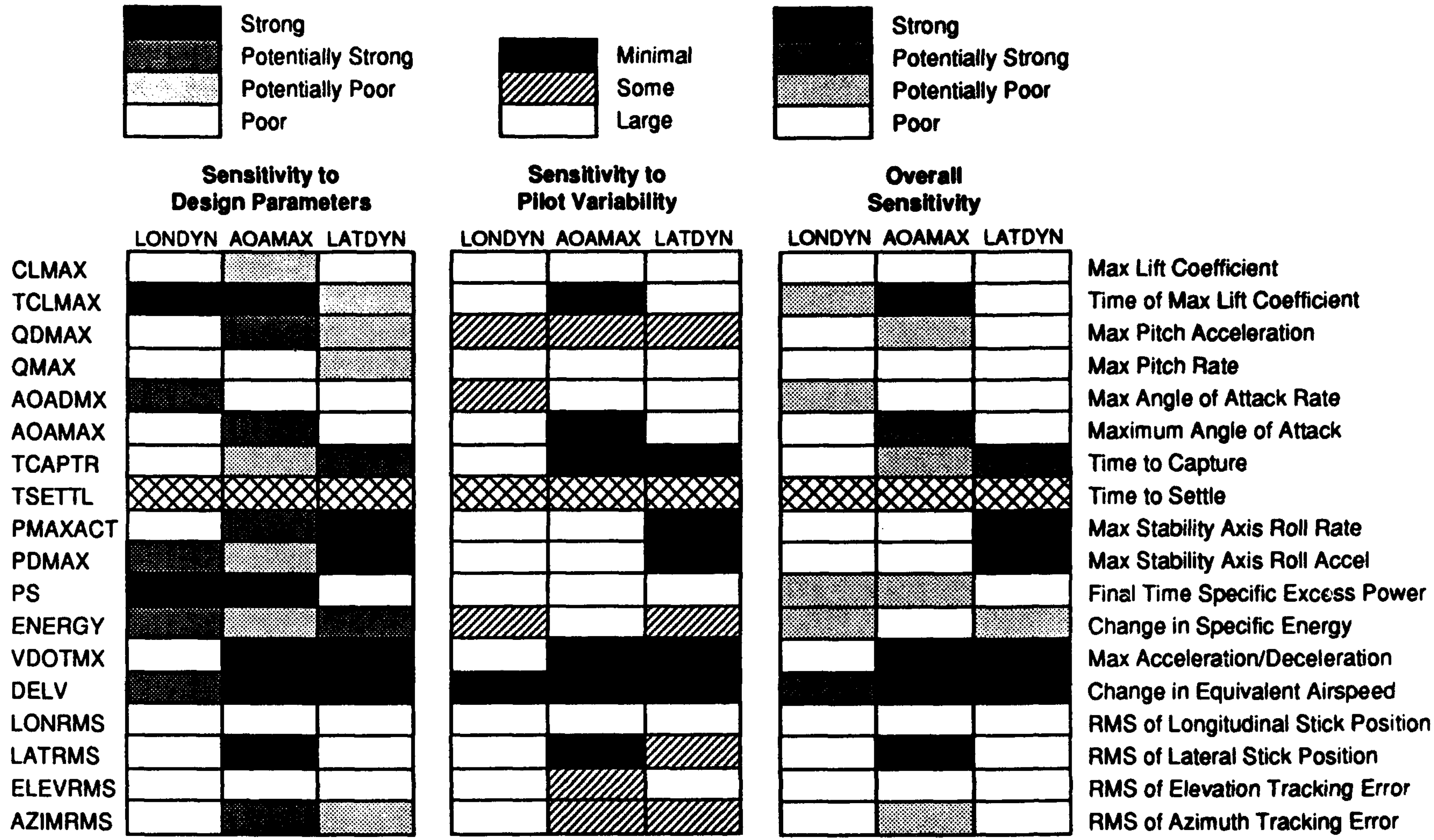
STEM 4 TEST 1 ANALYSIS C

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 42 | LONRMS | 0.946 | LONDYN | 0.063 | 0.5518 | 0.5574 | 0 | 0 | 0.010 | 0.02 | 4 | 3 | 4 |
| | | | AOAMAX | 0.180 | 0.5633 | 0.5468 | 0 | 0 | -0.030 | 0.06 | 4 | 3 | 4 |
| | | | LATDYN | 0.413 | 0.5716 | 0.5344 | 0 | 0 | -0.067 | 0.14 | 4 | 3 | 4 |
| | | | PLT | 0.998 | 0.4372 | 0.6911 | 0 | 0 | 0.474 | | | | |
| 43 | LATRMS | 0.9993 | LONDYN | 0.089 | 0.6651 | 0.6796 | 0 | 0 | 0.022 | 0.27 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 0.2331 | 1.0477 | 0 | 0 | 2.136 | 26.98 | 1 | 1 | 1 |
| | | | LATDYN | 0.619 | 0.6434 | 0.7048 | 0 | 0 | 0.091 | 1.15 | 4 | 2 | 4 |
| | | | PLT | 0.042 | 0.6962 | 0.6433 | 0 | 0 | -0.079 | | | | |
| 44 | ELEVRMS | 0.4425 | LONDYN | 0.330 | 0.9147 | 0.8757 | 0 | 0 | -0.044 | 0.59 | 4 | 3 | 4 |
| | | | AOAMAX | 0.535 | 0.859 | 0.9289 | 0 | 0 | 0.078 | 1.06 | 4 | 2 | 4 |
| | | | LATDYN | 0.152 | 0.9081 | 0.8834 | 0 | 0 | -0.028 | 0.37 | 4 | 3 | 4 |
| | | | PLT | 0.473 | 0.9271 | 0.8611 | 0 | 0 | -0.074 | | | | |
| 45 | AZIMRMS | 0.8871 | LONDYN | 0.494 | 1.0996 | 1.2181 | 0 | 0 | 0.103 | 0.47 | 4 | 3 | 4 |
| | | | AOAMAX | 0.977 | 0.9258 | 1.3502 | 0 | 0 | 0.386 | 1.76 | 2 | 2 | 3 |
| | | | LATDYN | 0.895 | 1.0269 | 1.303 | 0 | 0 | 0.240 | 1.10 | 3 | 2 | 4 |
| | | | PLT | 0.827 | 1.2688 | 1.0207 | 0 | 0 | -0.219 | | | | |

STEM 4 TEST 1 ANALYSIS C



STEM 4 TEST 1 ANALYSIS C

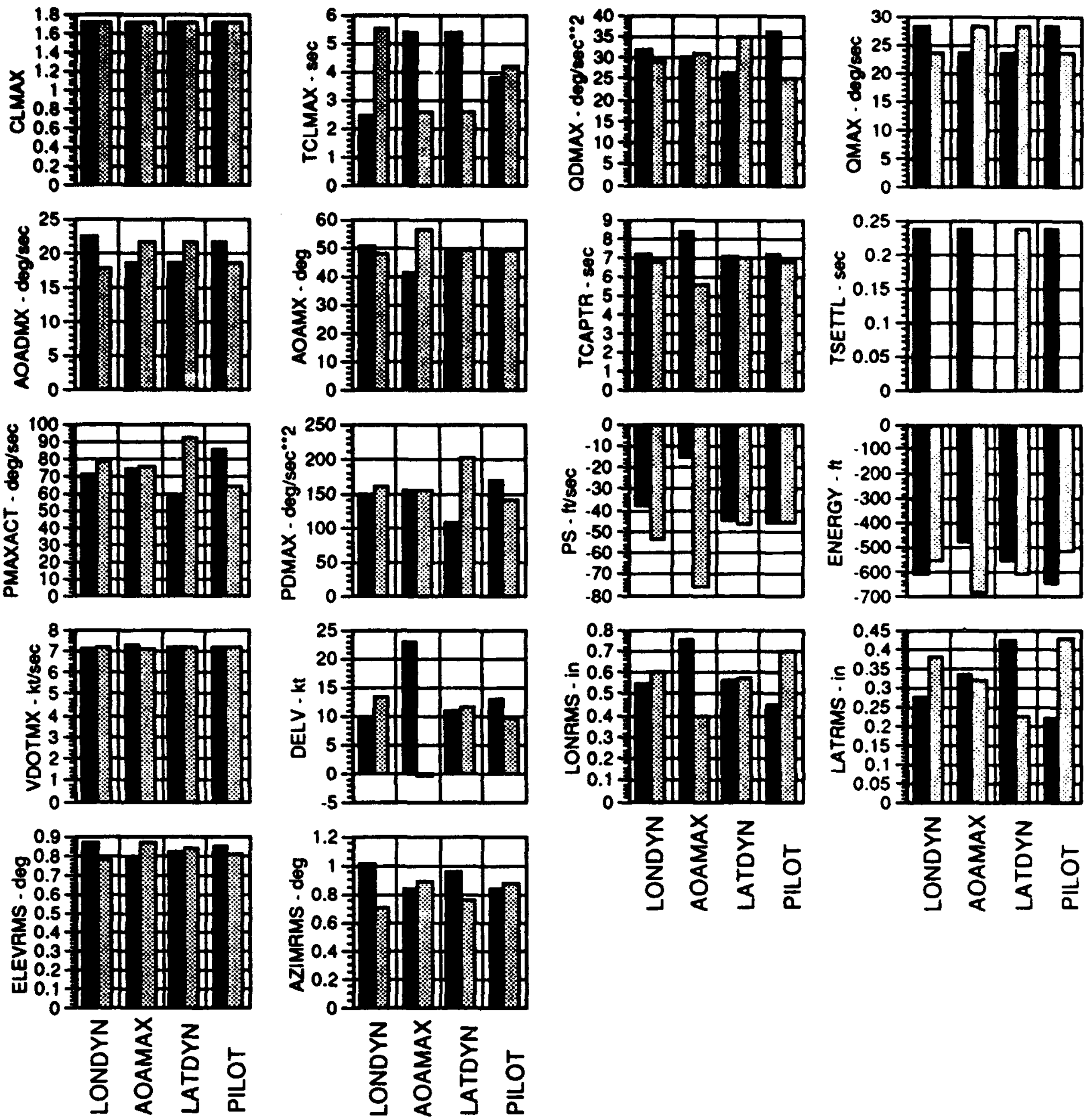


| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | CLMAX | 0.7453 | LONDYN | 0.957 | 1.7195 | 1.7183 | 0 | 0 | -0.001 | 16.86 | 4 | 1 | 4 |
| | | | AOAMAX | 0.264 | 1.7188 | 1.719 | 0 | 0 | 0.000 | 2.71 | 4 | 1 | 4 |
| | | | LATDYN | 0.936 | 1.7183 | 1.7194 | 0 | 0 | 0.001 | 15.29 | 4 | 1 | 4 |
| | | | PLT | 0.108 | 1.7188 | 1.7189 | 0 | 0 | 0.000 | | | | |
| 3 | TCLMAX | 0.9999 | LONDYN | 1.000 | 2.4515 | 5.484 | 0 | 0 | 0.895 | 9.43 | 1 | 1 | 1 |
| | | | AOAMAX | 1.000 | 5.3721 | 2.5634 | 0 | 0 | -0.809 | 8.53 | 1 | 1 | 1 |
| | | | LATDYN | 1.000 | 5.3893 | 2.5461 | 0 | 0 | -0.822 | 8.67 | 1 | 1 | 1 |
| | | | PLT | 0.994 | 3.7799 | 4.1555 | 0 | 0 | 0.095 | | | | |
| 6 | QDMAX | 0.9812 | LONDYN | 0.557 | 31.95 | 29.293 | 0 | 0 | -0.087 | 0.23 | 4 | 3 | 4 |
| | | | AOAMAX | 0.170 | 30.252 | 30.991 | 0 | 0 | 0.024 | 0.07 | 4 | 3 | 4 |
| | | | LATDYN | 0.974 | 26.489 | 34.755 | 0 | 0 | 0.275 | 0.74 | 2 | 3 | 4 |
| | | | PLT | 0.995 | 36.118 | 25.126 | 0 | 0 | -0.371 | | | | |
| 8 | QMAX | 0.9999 | LONDYN | 1.000 | 28.245 | 23.602 | 0 | 0 | -0.181 | 1.04 | 3 | 2 | 4 |
| | | | AOAMAX | 1.000 | 23.622 | 28.224 | 0 | 0 | 0.179 | 1.03 | 3 | 2 | 4 |
| | | | LATDYN | 1.000 | 23.665 | 28.182 | 0 | 0 | 0.176 | 1.01 | 3 | 2 | 4 |
| | | | PLT | 1.000 | 28.156 | 23.691 | 0 | 0 | -0.174 | | | | |
| 11 | AOADMX | 0.9991 | LONDYN | 1.000 | 22.315 | 17.708 | 0 | 0 | -0.233 | 1.50 | 2 | 2 | 3 |
| | | | AOAMAX | 0.986 | 18.569 | 21.454 | 0 | 0 | 0.145 | 0.93 | 3 | 3 | 4 |
| | | | LATDYN | 0.985 | 18.591 | 21.433 | 0 | 0 | 0.143 | 0.92 | 3 | 3 | 4 |
| | | | PLT | 0.991 | 21.558 | 18.465 | 0 | 0 | -0.155 | | | | |
| 20 | AOAMX | 0.9999 | LONDYN | 1.000 | 50.451 | 47.481 | 0 | 0 | -0.061 | 9.17 | 4 | 1 | 4 |
| | | | AOAMAX | 1.000 | 41.358 | 56.575 | 0 | 0 | 0.318 | 48.10 | 2 | 1 | 2 |
| | | | LATDYN | 0.899 | 48.631 | 49.302 | 0 | 0 | 0.014 | 2.07 | 4 | 1 | 4 |
| | | | PLT | 0.586 | 48.804 | 49.128 | 0 | 0 | 0.007 | | | | |
| 25 | TCAPTR | 0.9999 | LONDYN | 0.757 | 7.1306 | 6.809 | 0 | 0 | -0.046 | 0.76 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 8.3512 | 5.5884 | 0 | 0 | -0.413 | 6.84 | 1 | 1 | 1 |
| | | | LATDYN | 0.259 | 7.0143 | 6.9253 | 0 | 0 | -0.013 | 0.21 | 4 | 3 | 4 |
| | | | PLT | 0.868 | 7.1799 | 6.7597 | 0 | 0 | -0.060 | | | | |
| 26 | TSETTL | 0.5337 | LONDYN | 0.668 | 0.2375 | 0 | 0 | 0 | 0.000 | #NUM! | 4 | #NUM! | #NUM! |
| | | | AOAMAX | 0.668 | 0.2375 | 0 | 0 | 0 | 0.000 | #NUM! | 4 | #NUM! | #NUM! |
| | | | LATDYN | 0.668 | 0 | 0.2375 | 0 | 0 | 0.000 | #NUM! | 4 | #NUM! | #NUM! |
| | | | PLT | 0.668 | 0.2375 | 0 | 0 | 0 | 0.000 | | | | |
| 30 | PMAXACT | 0.9999 | LONDYN | 0.985 | 70.298 | 78.948 | 0 | 0 | 0.116 | 0.41 | 3 | 3 | 4 |
| | | | AOAMAX | 0.361 | 73.866 | 75.38 | 0 | 0 | 0.020 | 0.07 | 4 | 3 | 4 |
| | | | LATDYN | 1.000 | 57.417 | 91.829 | 0 | 0 | 0.487 | 1.72 | 1 | 2 | 2 |
| | | | PLT | 1.000 | 84.978 | 64.268 | 0 | 0 | -0.283 | | | | |
| 32 | PDMAX | 0.9999 | LONDYN | 0.948 | 147.94 | 160.45 | 0 | 0 | 0.081 | 0.48 | 4 | 3 | 4 |
| | | | AOAMAX | 0.030 | 154.31 | 154.08 | 0 | 0 | -0.001 | 0.01 | 4 | 3 | 4 |
| | | | LATDYN | 1.000 | 108 | 200.39 | 0 | 0 | 0.658 | 3.86 | 1 | 1 | 1 |
| | | | PLT | 1.000 | 167.26 | 141.14 | 0 | 0 | -0.171 | | | | |
| 36 | PS | 0.9999 | LONDYN | 0.975 | -37.763 | -53.294 | 0 | 0 | -0.351 | 27.98 | 2 | 1 | 2 |
| | | | AOAMAX | 1.000 | -15.093 | -75.964 | 0 | 0 | -2.417 | 192.49 | 1 | 1 | 1 |
| | | | LATDYN | 0.191 | -44.758 | -46.299 | 0 | 0 | -0.034 | 2.70 | 4 | 1 | 4 |
| | | | PLT | 0.071 | -45.814 | -45.243 | 0 | 0 | 0.013 | | | | |
| 37 | ENERGY | 0.9999 | LONDYN | 0.984 | -607.4 | -557.6 | 0 | 0 | 0.086 | 0.35 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | -480.15 | -684.84 | 0 | 0 | -0.363 | 1.49 | 2 | 2 | 3 |
| | | | LATDYN | 0.980 | -558.52 | -606.47 | 0 | 0 | -0.082 | 0.34 | 4 | 3 | 4 |
| | | | PLT | 1.000 | -652.31 | -512.69 | 0 | 0 | 0.243 | | | | |
| 38 | VDOTMX | 0.7386 | LONDYN | 0.791 | 7.1083 | 7.2047 | 0 | 0 | 0.013 | 5.83 | 4 | 1 | 4 |
| | | | AOAMAX | 0.925 | 7.2265 | 7.0865 | 0 | 0 | -0.020 | 8.47 | 4 | 1 | 4 |
| | | | LATDYN | 0.157 | 7.1639 | 7.1491 | 0 | 0 | -0.002 | 0.90 | 4 | 3 | 4 |
| | | | PLT | 0.175 | 7.1648 | 7.1482 | 0 | 0 | -0.002 | | | | |
| 39 | DELV | 0.9999 | LONDYN | 0.997 | 9.2044 | 13.209 | 0 | 0 | 0.369 | 1.18 | 2 | 2 | 3 |
| | | | AOAMAX | 1.000 | 23.022 | -0.6086 | 0 | 0 | -19.927 | 63.79 | 1 | 1 | 1 |
| | | | LATDYN | 0.258 | 11.015 | 11.399 | 0 | 0 | 0.034 | 0.11 | 4 | 3 | 4 |
| | | | PLT | 0.991 | 12.917 | 9.4571 | 0 | 0 | -0.312 | | | | |

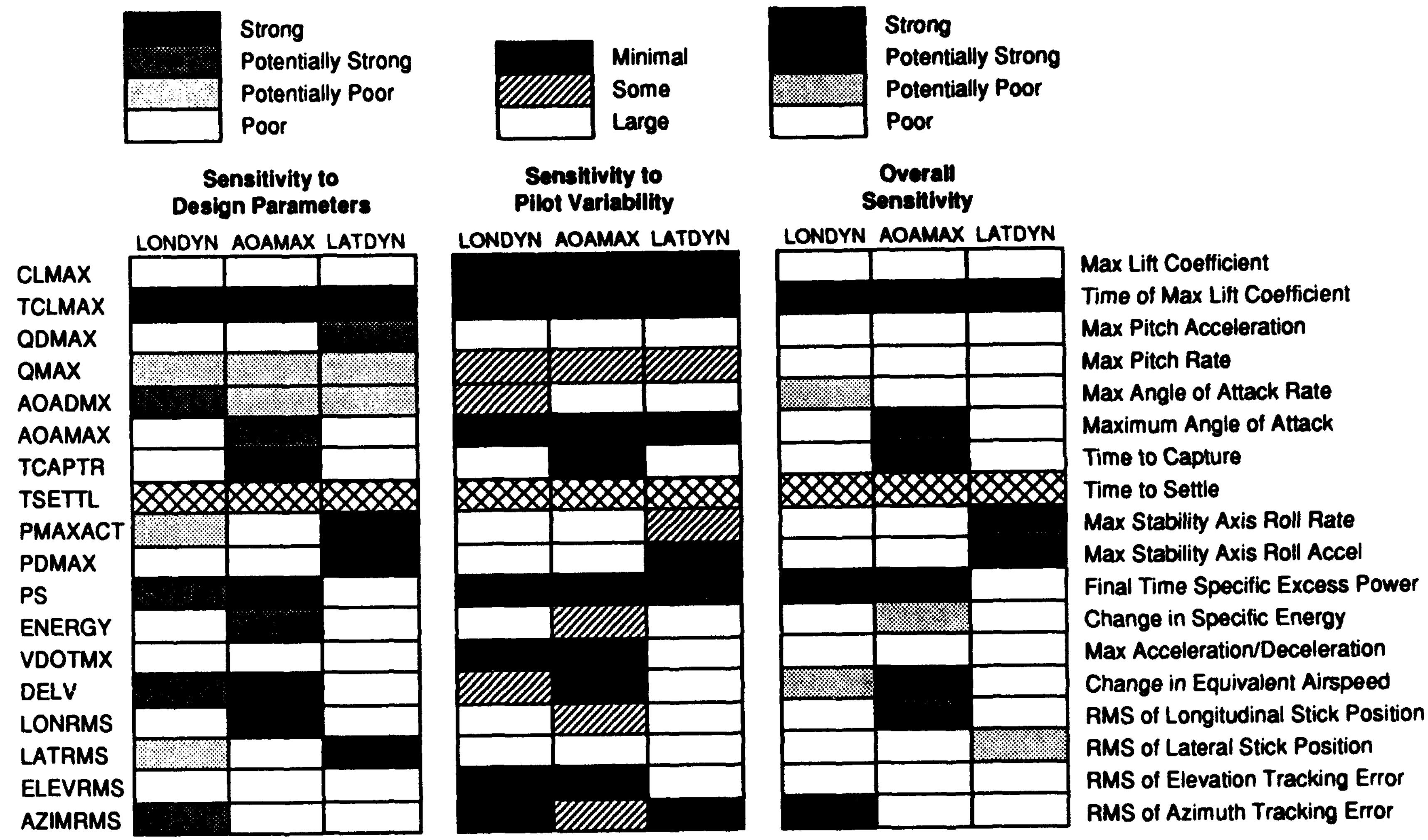
STEM 4 TEST 1 ANALYSIS D

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 42 | LONRMS | 0.9993 | LONDYN | 0.639 | 0.5434 | 0.6028 | 0 | 0 | 0.104 | 0.23 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 0.7513 | 0.3949 | 0 | 0 | -0.688 | 1.53 | 1 | 2 | 2 |
| | | | LATDYN | 0.089 | 0.5695 | 0.5767 | 0 | 0 | 0.013 | 0.03 | 4 | 3 | 4 |
| | | | PLT | 0.999 | 0.4504 | 0.6959 | 0 | 0 | 0.449 | | | | |
| 43 | LATRMS | 0.9852 | LONDYN | 0.860 | 0.2713 | 0.3775 | 0 | 0 | 0.336 | 0.47 | 3 | 3 | 4 |
| | | | AOAMAX | 0.148 | 0.3309 | 0.3179 | 0 | 0 | -0.040 | 0.06 | 4 | 3 | 4 |
| | | | LATDYN | 0.990 | 0.4247 | 0.2241 | 0 | 0 | -0.684 | 0.96 | 1 | 3 | 3 |
| | | | PLT | 0.992 | 0.2204 | 0.4285 | 0 | 0 | 0.715 | | | | |
| 44 | ELEVRMS | 0.7285 | LONDYN | 0.726 | 0.8704 | 0.7776 | 0 | 0 | -0.113 | 2.68 | 4 | 1 | 4 |
| | | | AOAMAX | 0.655 | 0.7842 | 0.8638 | 0 | 0 | 0.097 | 2.30 | 4 | 1 | 4 |
| | | | LATDYN | 0.212 | 0.8128 | 0.8352 | 0 | 0 | 0.027 | 0.64 | 4 | 3 | 4 |
| | | | PLT | 0.323 | 0.8413 | 0.8066 | 0 | 0 | -0.042 | | | | |
| 45 | AZIMRMS | 0.7058 | LONDYN | 0.914 | 1.0066 | 0.7056 | 0 | 0 | -0.363 | 6.32 | 2 | 1 | 2 |
| | | | AOAMAX | 0.241 | 0.8304 | 0.8818 | 0 | 0 | 0.060 | 1.05 | 4 | 2 | 4 |
| | | | LATDYN | 0.777 | 0.9605 | 0.7517 | 0 | 0 | -0.248 | 4.31 | 4 | 1 | 4 |
| | | | PLT | 0.231 | 0.8315 | 0.8807 | 0 | 0 | 0.057 | | | | |

STEM 4 TEST 1 ANALYSIS D



STEM 4 TEST 1 ANALYSIS D

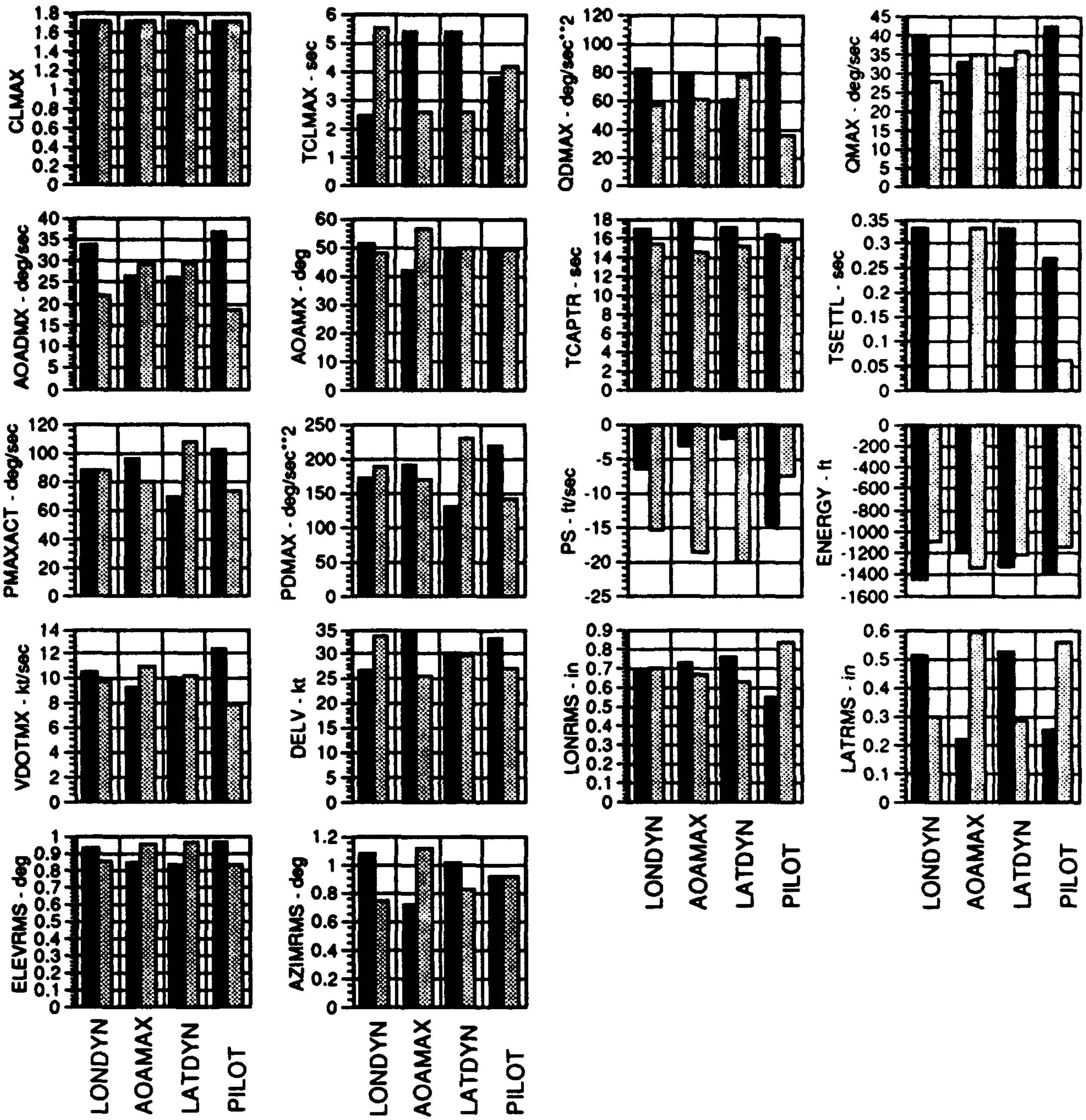


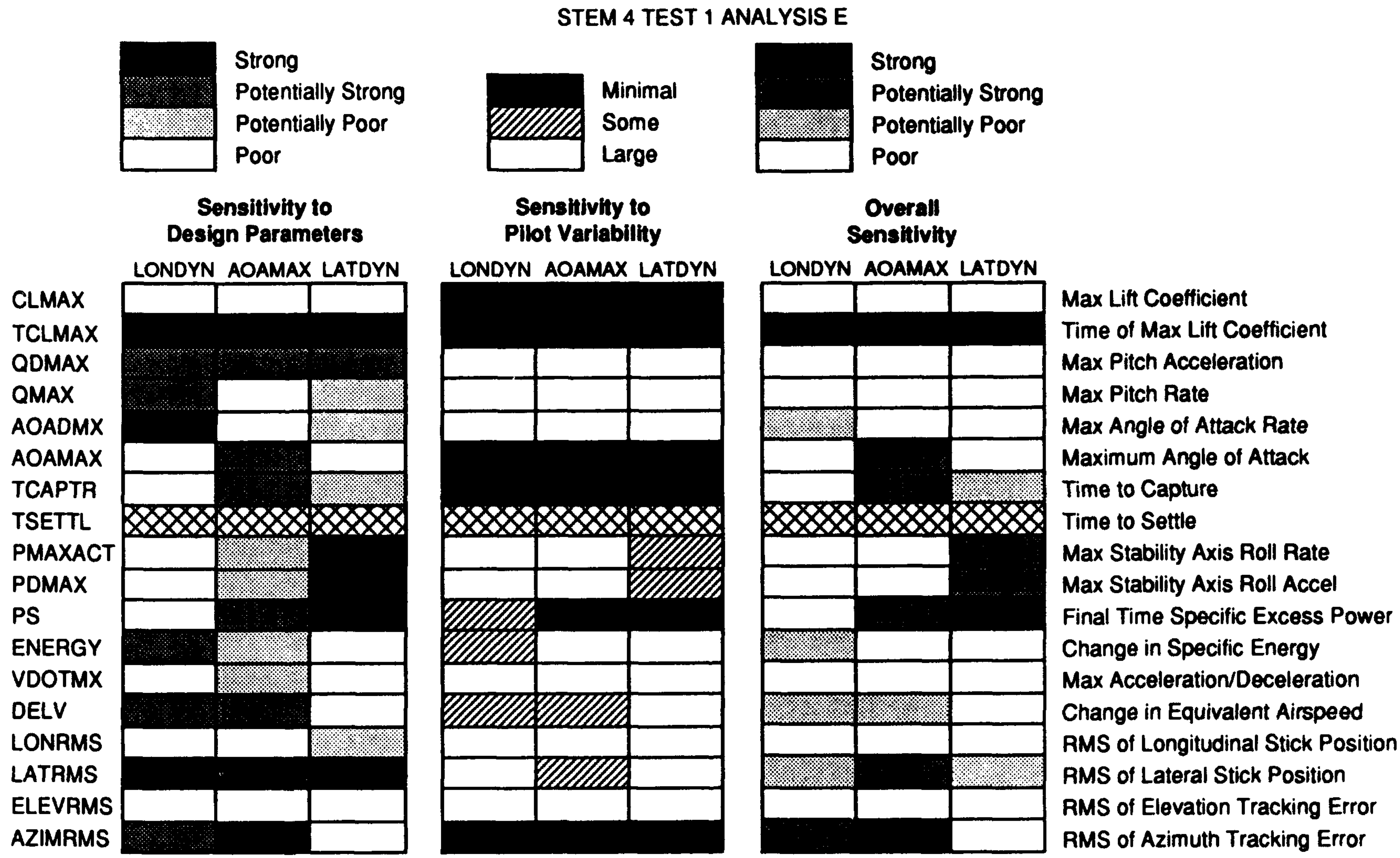
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | CLMAX | 0.7453 | LONDYN | 0.957 | 1.7195 | 1.7183 | 0 | 0 | -0.001 | 16.86 | 4 | 1 | 4 |
| | | | AOAMAX | 0.264 | 1.7188 | 1.719 | 0 | 0 | 0.000 | 2.71 | 4 | 1 | 4 |
| | | | LATDYN | 0.936 | 1.7183 | 1.7194 | 0 | 0 | 0.001 | 15.29 | 4 | 1 | 4 |
| | | | PLT | 0.108 | 1.7188 | 1.7189 | 0 | 0 | 0.000 | | | | |
| 3 | TCLMAX | 0.9999 | LONDYN | 1.000 | 2.4514 | 5.4838 | 0 | 0 | 0.895 | 9.43 | 1 | 1 | 1 |
| | | | AOAMAX | 1.000 | 5.3719 | 2.5633 | 0 | 0 | -0.809 | 8.53 | 1 | 1 | 1 |
| | | | LATDYN | 1.000 | 5.3892 | 2.546 | 0 | 0 | -0.822 | 8.67 | 1 | 1 | 1 |
| | | | PLT | 0.994 | 3.7798 | 4.1554 | 0 | 0 | 0.095 | | | | |
| 6 | QDMAX | 0.9999 | LONDYN | 0.998 | 82.104 | 56.779 | 0 | 0 | -0.377 | 0.29 | 2 | 3 | 4 |
| | | | AOAMAX | 0.970 | 77.404 | 61.479 | 0 | 0 | -0.232 | 0.18 | 2 | 3 | 4 |
| | | | LATDYN | 0.971 | 61.471 | 77.412 | 0 | 0 | 0.233 | 0.18 | 2 | 3 | 4 |
| | | | PLT | 1.000 | 103.4 | 35.485 | 0 | 0 | -1.285 | | | | |
| 8 | QMAX | 0.9999 | LONDYN | 1.000 | 39.162 | 28.037 | 0 | 0 | -0.340 | 0.59 | 2 | 3 | 4 |
| | | | AOAMAX | 0.618 | 32.578 | 34.622 | 0 | 0 | 0.061 | 0.11 | 4 | 3 | 4 |
| | | | LATDYN | 0.953 | 31.147 | 36.053 | 0 | 0 | 0.147 | 0.26 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 42.536 | 24.663 | 0 | 0 | -0.572 | | | | |
| 11 | AOADMX | 0.9999 | LONDYN | 1.000 | 33.413 | 22.163 | 0 | 0 | -0.422 | 0.58 | 1 | 3 | 3 |
| | | | AOAMAX | 0.820 | 26.365 | 29.211 | 0 | 0 | 0.103 | 0.14 | 4 | 3 | 4 |
| | | | LATDYN | 0.910 | 25.959 | 29.617 | 0 | 0 | 0.132 | 0.18 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 36.893 | 18.683 | 0 | 0 | -0.734 | | | | |
| 20 | AOAMX | 0.9999 | LONDYN | 1.000 | 51.055 | 47.481 | 0 | 0 | -0.073 | 12.83 | 4 | 1 | 4 |
| | | | AOAMAX | 1.000 | 41.928 | 56.608 | 0 | 0 | 0.305 | 53.83 | 2 | 1 | 2 |
| | | | LATDYN | 0.992 | 48.664 | 49.872 | 0 | 0 | 0.025 | 4.33 | 4 | 1 | 4 |
| | | | PLT | 0.505 | 49.407 | 49.128 | 0 | 0 | -0.006 | | | | |
| 25 | TCAPTR | 0.9983 | LONDYN | 0.957 | 16.86 | 15.351 | 0 | 0 | -0.094 | 2.45 | 4 | 1 | 4 |
| | | | AOAMAX | 1.000 | 17.784 | 14.426 | 0 | 0 | -0.211 | 5.51 | 2 | 1 | 2 |
| | | | LATDYN | 0.992 | 17.135 | 15.075 | 0 | 0 | -0.128 | 3.36 | 3 | 1 | 3 |
| | | | PLT | 0.617 | 16.413 | 15.797 | 0 | 0 | -0.038 | | | | |
| 26 | TSETTL | 0.4946 | LONDYN | 0.752 | 0.3333 | 0 | 0 | 0 | 0.000 | 0.00 | 4 | 3 | 4 |
| | | | AOAMAX | 0.752 | 0 | 0.3333 | 0 | 0 | 0.000 | 0.00 | 4 | 3 | 4 |
| | | | LATDYN | 0.752 | 0.3333 | 0 | 0 | 0 | 0.000 | 0.00 | 4 | 3 | 4 |
| | | | PLT | 0.536 | 0.2708 | 0.0625 | 0 | 0 | -2.051 | | | | |
| 30 | PMAXACT | 0.9999 | LONDYN | 0.116 | 87.79 | 87.35 | 0 | 0 | -0.005 | 0.02 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 95.706 | 79.434 | 0 | 0 | -0.187 | 0.56 | 3 | 3 | 4 |
| | | | LATDYN | 1.000 | 68.187 | 106.95 | 0 | 0 | 0.465 | 1.39 | 1 | 2 | 2 |
| | | | PLT | 1.000 | 101.81 | 73.327 | 0 | 0 | -0.334 | | | | |
| 32 | PDMAX | 0.9999 | LONDYN | 0.761 | 172.24 | 187.52 | 0 | 0 | 0.085 | 0.19 | 4 | 3 | 4 |
| | | | AOAMAX | 0.922 | 191.65 | 168.11 | 0 | 0 | -0.131 | 0.30 | 3 | 3 | 4 |
| | | | LATDYN | 1.000 | 129.91 | 229.85 | 0 | 0 | 0.602 | 1.35 | 1 | 2 | 2 |
| | | | PLT | 1.000 | 218.07 | 141.68 | 0 | 0 | -0.445 | | | | |
| 36 | PS | 0.8077 | LONDYN | 0.648 | -6.6191 | -15.498 | 0 | 0 | -0.957 | [illegible] | 4 | 2 | 4 |
| | | | AOAMAX | 0.888 | -3.2758 | -18.841 | 0 | 0 | -2.789 | 3.95 | 2 | 1 | 2 |
| | | | LATDYN | 0.934 | -1.9235 | -20.194 | 0 | 0 | -5.202 | 7.36 | 1 | 1 | 1 |
| | | | PLT | 0.541 | -14.572 | -7.545 | 0 | 0 | 0.707 | | | | |
| 37 | ENERGY | 0.9975 | LONDYN | 1.000 | -1441.9 | -1092.4 | 0 | 0 | 0.281 | 1.40 | 2 | 2 | 3 |
| | | | AOAMAX | 0.919 | -1194.4 | -1339.9 | 0 | 0 | -0.115 | 0.57 | 3 | 3 | 4 |
| | | | LATDYN | 0.797 | -1319 | -1215.3 | 0 | 0 | 0.082 | 0.41 | 4 | 3 | 4 |
| | | | PLT | 0.995 | -1393.5 | -1140.8 | 0 | 0 | 0.201 | | | | |
| 38 | VDOTMX | 0.9999 | LONDYN | 0.958 | 10.51 | 9.776 | 0 | 0 | -0.072 | 0.15 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 9.2346 | 11.051 | 0 | 0 | 0.181 | 0.38 | 3 | 3 | 4 |
| | | | LATDYN | 0.507 | 10.026 | 10.26 | 0 | 0 | 0.023 | 0.05 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 12.447 | 7.8384 | 0 | 0 | -0.479 | | | | |
| 39 | DELV | 0.9999 | LONDYN | 1.000 | 26.561 | 33.568 | 0 | 0 | 0.236 | 1.12 | 2 | 2 | 3 |
| | | | AOAMAX | 1.000 | 34.716 | 25.413 | 0 | 0 | -0.317 | 1.50 | 2 | 2 | 3 |
| | | | LATDYN | 0.153 | 30.217 | 29.912 | 0 | 0 | -0.010 | 0.05 | 4 | 3 | 4 |
| | | | PLT | 0.999 | 33.198 | 26.931 | 0 | 0 | -0.211 | | | | |

STEM 4 TEST 1 ANALYSIS E

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 42 | LONRMS | 0.9992 | LONDYN | 0.247 | 0.6837 | 0.6992 | 0 | 0 | 0.022 | 0.05 | 4 | 3 | 4 |
| | | | AOAMAX | 0.764 | 0.7213 | 0.6616 | 0 | 0 | -0.086 | 0.19 | 4 | 3 | 4 |
| | | | LATDYN | 0.985 | 0.7579 | 0.6251 | 0 | 0 | -0.194 | 0.44 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 0.5448 | 0.8381 | 0 | 0 | 0.444 | | | | |
| 43 | LATRMS | 0.9967 | LONDYN | 0.932 | 0.5078 | 0.3006 | 0 | 0 | -0.549 | 0.62 | 1 | 3 | 3 |
| | | | AOAMAX | 0.997 | 0.2161 | 0.5923 | 0 | 0 | 1.188 | 1.35 | 1 | 2 | 2 |
| | | | LATDYN | 0.960 | 0.5221 | 0.2863 | 0 | 0 | -0.638 | 0.72 | 1 | 3 | 3 |
| | | | PLT | 0.989 | 0.2514 | 0.557 | 0 | 0 | 0.882 | | | | |
| 44 | ELEVRMS | 0.7601 | LONDYN | 0.596 | 0.9347 | 0.8569 | 0 | 0 | -0.087 | 0.57 | 4 | 3 | 4 |
| | | | AOAMAX | 0.757 | 0.8408 | 0.9508 | 0 | 0 | 0.123 | 0.81 | 4 | 3 | 4 |
| | | | LATDYN | 0.807 | 0.8341 | 0.9575 | 0 | 0 | 0.138 | 0.91 | 4 | 3 | 4 |
| | | | PLT | 0.843 | 0.9632 | 0.8283 | 0 | 0 | -0.151 | | | | |
| 45 | AZIMRMS | 0.9206 | LONDYN | 0.969 | 1.081 | 0.7458 | 0 | 0 | -0.380 | 35.87 | 2 | 1 | 2 |
| | | | AOAMAX | 0.987 | 0.7149 | 1.112 | 0 | 0 | 0.456 | 43.10 | 1 | [illegible] | 1 |
| | | | LATDYN | 0.800 | 1.0082 | 0.8187 | 0 | 0 | -0.210 | 19.81 | 4 | 1 | 4 |
| | | | PLT | 0.054 | 0.9183 | 0.9086 | 0 | 0 | -0.011 | | | | |

STEM 4 TEST 1 ANALYSIS E



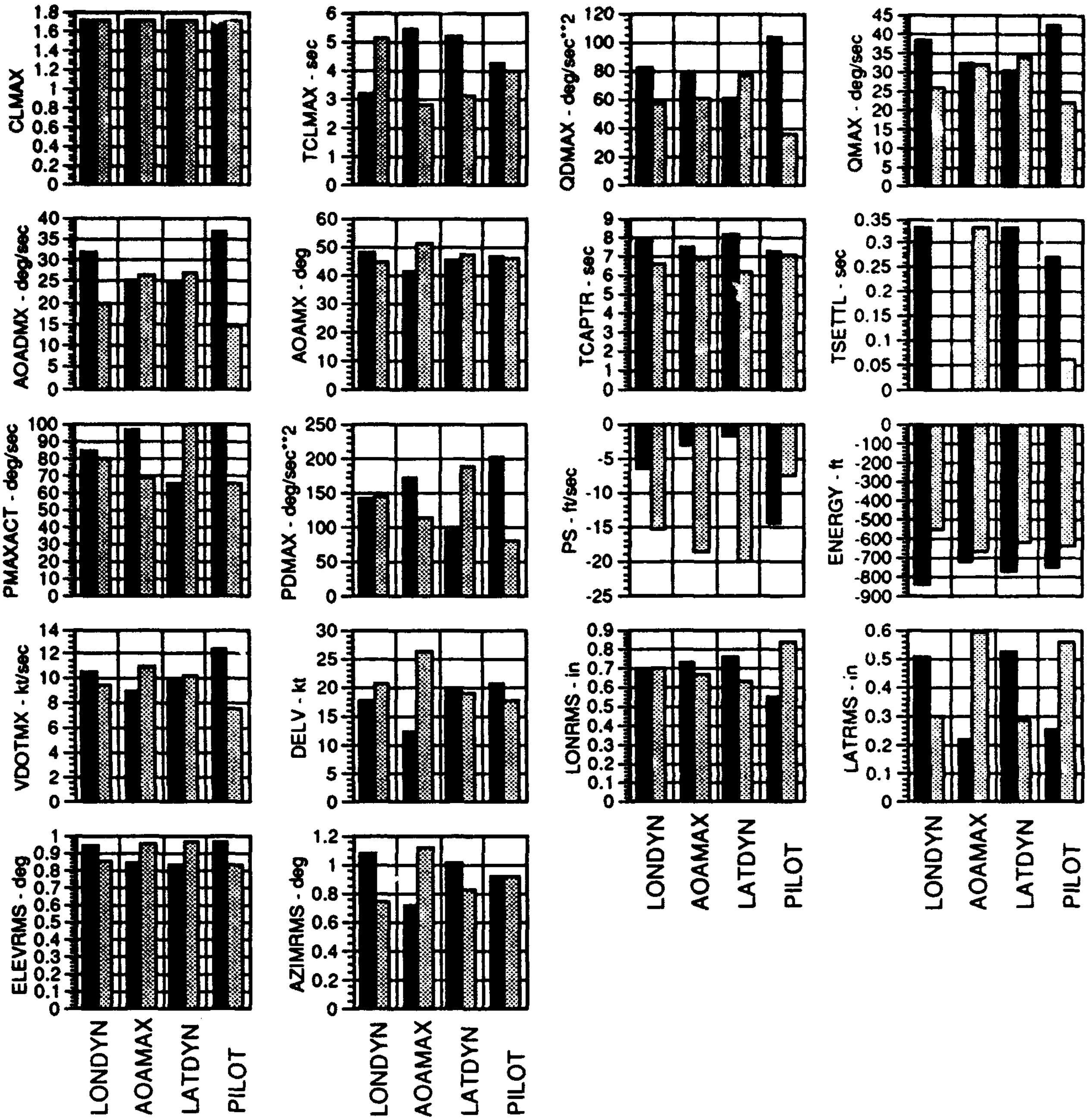

STEM 4 TEST 1 ANALYSIS E
Strong
Potentially Strong
Potentially Poor
Poor
Minimal
Some
Large
Strong
Potentially Strong
Potentially Poor
Poor
Sensitivity to Design Parameters
Sensitivity to Pilot Variability
Overall Sensitivity
LONDYN AOAMAX LATDYN
LONDYN AOAMAX LATDYN
LONDYN AOAMAX LATDYN
CLMAX
TCLMAX
QDMAX
QMAX
AOADMX
AOAMAX
TCAPTR
TSETTL
PMAXACT
PDMAX
PS
ENERGY
VDOTMX
DELV
LONRMS
LATRMS
ELEVRMS
AZIMRMS
Max Lift Coefficient
Time of Max Lift Coefficient
Max Pitch Acceleration
Max Pitch Rate
Max Angle of Attack Rate
Maximum Angle of Attack
Time to Capture
Time to Settle
Max Stability Axis Roll Rate
Max Stability Axis Roll Accel
Final Time Specific Excess Power
Change in Specific Energy
Max Acceleration/Deceleration
Change in Equivalent Airspeed
RMS of Longitudinal Stick Position
RMS of Lateral Stick Position
RMS of Elevation Tracking Error
RMS of Azimuth Tracking Error

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | CLMAX | 0.9999 | LONDYN | 0.999 | 1.718 | 1.7134 | 0 | 0 | -0.003 | 1.28 | 4 | 2 | 4 |
| | | | AOAMAX | 1.000 | 1.7129 | 1.7185 | 0 | 0 | 0.003 | 1.54 | 4 | 2 | 4 |
| | | | LATDYN | 1.000 | 1.7118 | 1.7196 | 0 | 0 | 0.005 | 2.16 | 4 | 1 | 4 |
| | | | PLT | 0.993 | 1.7139 | 1.7175 | 0 | 0 | 0.002 | | | | |
| 3 | TCLMAX | 0.9999 | LONDYN | 1.000 | 3.1458 | 5.0916 | 0 | 0 | 0.500 | 8.99 | 1 | 1 | 1 |
| | | | AOAMAX | 1.000 | 5.4541 | 2.7833 | 0 | 0 | -0.725 | 13.02 | 1 | 1 | 1 |
| | | | LATDYN | 1.000 | 5.1583 | 3.0791 | 0 | 0 | -0.539 | 9.69 | 1 | 1 | 1 |
| | | | PLT | 0.397 | 4.2332 | 4.0042 | 0 | 0 | -0.056 | | | | |
| 6 | QDMAX | 0.9999 | LONDYN | 0.998 | 82.104 | 56.779 | 0 | 0 | -0.377 | 0.29 | 2 | 3 | 4 |
| | | | AOAMAX | 0.970 | 77.404 | 61.479 | 0 | 0 | -0.232 | 0.18 | 2 | 3 | 4 |
| | | | LATDYN | 0.971 | 61.471 | 77.412 | 0 | 0 | 0.233 | 0.18 | 2 | 3 | 4 |
| | | | PLT | 1.000 | 103.4 | 35.485 | 0 | 0 | -1.285 | | | | |
| 8 | QMAX | 0.9999 | LONDYN | 1.000 | 38.281 | 25.971 | 0 | 0 | -0.398 | 0.55 | 2 | 3 | 4 |
| | | | AOAMAX | 0.266 | 32.546 | 31.706 | 0 | 0 | -0.026 | 0.04 | 4 | 3 | 4 |
| | | | LATDYN | 0.848 | 30.296 | 33.956 | 0 | 0 | 0.114 | 0.16 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 42.536 | 21.716 | 0 | 0 | -0.724 | | | | |
| 11 | AOADMX | 0.9999 | LONDYN | 1.000 | 31.933 | 19.679 | 0 | 0 | -0.503 | 0.48 | 1 | 3 | 3 |
| | | | AOAMAX | 0.503 | 25.063 | 26.549 | 0 | 0 | 0.058 | 0.05 | 4 | 3 | 4 |
| | | | LATDYN | 0.757 | 24.512 | 27.101 | 0 | 0 | 0.101 | 0.10 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 36.893 | 14.719 | 0 | 0 | -1.054 | | | | |
| 20 | AOAMX | 0.9999 | LONDYN | 1.000 | 48.064 | 44.217 | 0 | 0 | -0.084 | 4.71 | 4 | 1 | 4 |
| | | | AOAMAX | 1.000 | 41.14 | 51.141 | 0 | 0 | 0.219 | 12.36 | 2 | 1 | 2 |
| | | | LATDYN | 0.928 | 45.278 | 47.003 | 0 | 0 | 0.037 | 2.11 | 4 | 1 | 4 |
| | | | PLT | 0.626 | 46.55 | 45.731 | 0 | 0 | -0.018 | | | | |
| 25 | TCAPTR | 0.9705 | LONDYN | 0.956 | 7.7292 | 6.5416 | 0 | 0 | -0.168 | 6.11 | 3 | 1 | 3 |
| | | | AOAMAX | 0.710 | 7.4333 | 6.8375 | 0 | 0 | -0.084 | 3.05 | 4 | 1 | 4 |
| | | | LATDYN | 0.998 | 8.1208 | 6.15 | 0 | 0 | -0.282 | 10.27 | 2 | 1 | 2 |
| | | | PLT | 0.276 | 7.2332 | 7.0375 | 0 | 0 | -0.027 | | | | |
| 26 | TSETTL | 0.4946 | LONDYN | 0.752 | 0.3333 | 0 | 0 | 0 | 0.000 | 0.00 | 4 | 3 | 4 |
| | | | AOAMAX | 0.752 | 0 | 0.3333 | 0 | 0 | 0.000 | 0.00 | 4 | 3 | 4 |
| | | | LATDYN | 0.752 | 0.3333 | 0 | 0 | 0 | 0.000 | 0.00 | 4 | 3 | 4 |
| | | | PLT | 0.536 | 0.2708 | 0.0625 | 0 | 0 | -2.051 | | | | |
| 30 | PMAXACT | 0.9999 | LONDYN | 0.753 | 84.27 | 80.126 | 0 | 0 | -0.050 | 0.11 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 95.706 | 68.69 | 0 | 0 | -0.338 | 0.76 | 2 | 3 | 4 |
| | | | LATDYN | 1.000 | 64.667 | 99.729 | 0 | 0 | 0.447 | 1.00 | 1 | 3 | 3 |
| | | | PLT | 1.000 | 99.737 | 64.659 | 0 | 0 | -0.447 | | | | |
| 32 | PDMAX | 0.9999 | LONDYN | 0.122 | 139.47 | 142.35 | 0 | 0 | 0.020 | 0.02 | 4 | 3 | 4 |
| | | | AOAMAX | 0.993 | 169.84 | 111.99 | 0 | 0 | -0.429 | 0.39 | 1 | 3 | 3 |
| | | | LATDYN | 1.000 | 94.615 | 187.21 | 0 | 0 | 0.737 | 0.67 | 1 | 3 | 3 |
| | | | PLT | 1.000 | 202.94 | 78.884 | 0 | 0 | -1.092 | | | | |
| 36 | PS | 0.811 | LONDYN | 0.653 | -6.5566 | -15.498 | 0 | 0 | -0.970 | 1.38 | 4 | 2 | 4 |
| | | | AOAMAX | 0.887 | -3.2758 | -18.779 | 0 | 0 | -2.779 | 3.96 | 2 | 1 | 2 |
| | | | LATDYN | 0.936 | -1.8609 | -20.194 | 0 | 0 | -5.380 | 7.67 | 1 | 1 | 1 |
| | | | PLT | 0.538 | -14.51 | -7.545 | 0 | 0 | 0.702 | | | | |
| 37 | ENERGY | 0.9876 | LONDYN | 0.999 | -846.3 | -549.91 | 0 | 0 | 0.445 | 2.75 | 1 | 1 | 1 |
| | | | AOAMAX | 0.458 | -720.64 | -675.57 | 0 | 0 | 0.065 | 0.40 | 4 | 3 | 4 |
| | | | LATDYN | 0.946 | -773.37 | -622.84 | 0 | 0 | 0.218 | 1.35 | 2 | 2 | 3 |
| | | | PLT | 0.860 | -754.24 | -641.97 | 0 | 0 | 0.162 | | | | |
| 38 | VDOTMX | 0.9999 | LONDYN | 0.993 | 10.509 | 9.4557 | 0 | 0 | -0.106 | 0.20 | 3 | 3 | 4 |
| | | | AOAMAX | 1.000 | 8.914 | 11.051 | 0 | 0 | 0.217 | 0.41 | 2 | 3 | 4 |
| | | | LATDYN | 0.876 | 9.7058 | 10.259 | 0 | 0 | 0.055 | 0.11 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 12.447 | 7.5178 | 0 | 0 | -0.526 | | | | |
| 39 | DELV | 0.9999 | LONDYN | 0.864 | 17.614 | 20.534 | 0 | 0 | 0.154 | 1.02 | 4 | 2 | 4 |
| | | | AOAMAX | 1.000 | 12.08 | 26.068 | 0 | 0 | 0.847 | 5.60 | 1 | 1 | 1 |
| | | | LATDYN | 0.277 | 19.41 | 18.738 | 0 | 0 | -0.035 | 0.23 | 4 | 3 | 4 |
| | | | PLT | 0.857 | 20.509 | 17.639 | 0 | 0 | -0.151 | | | | |

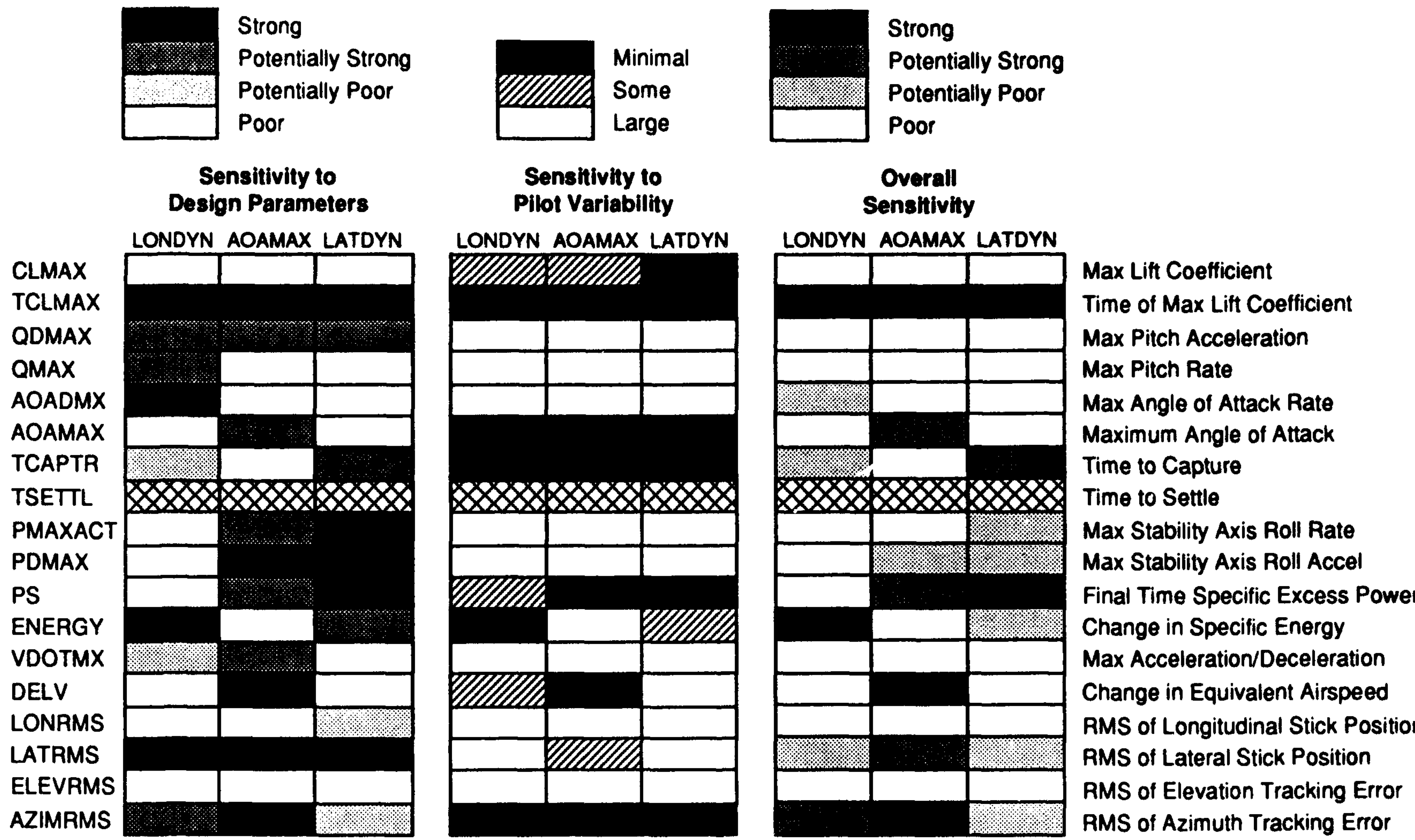
STEM 4 TEST 1 ANALYSIS F

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 42 | LONRMS | 0.9992 | LONDYN | 0.248 | 0.6836 | 0.6992 | 0 | 0 | 0.023 | 0.05 | 4 | 3 | 4 |
| | | | AOAMAX | 0.764 | 0.7213 | 0.6615 | 0 | 0 | -0.087 | 0.19 | 4 | 3 | 4 |
| | | | LATDYN | 0.985 | 0.7578 | 0.6251 | 0 | 0 | -0.194 | 0.44 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 0.5447 | 0.8381 | 0 | 0 | 0.444 | | | | |
| 43 | LATRMS | 0.9967 | LONDYN | 0.931 | 0.5073 | 0.3006 | 0 | 0 | -0.548 | 0.62 | 1 | 3 | 3 |
| | | | AOAMAX | 0.997 | 0.2161 | 0.5918 | 0 | 0 | 1.187 | 1.34 | 1 | 2 | 2 |
| | | | LATDYN | 0.959 | 0.5217 | 0.2863 | 0 | 0 | -0.637 | 0.72 | 1 | 3 | 3 |
| | | | PLT | 0.989 | 0.2509 | 0.557 | 0 | 0 | 0.885 | | | | |
| 44 | ELEVRMS | 0.7612 | LONDYN | 0.597 | 0.9349 | 0.8569 | 0 | 0 | -0.087 | 0.58 | 4 | 3 | 4 |
| | | | AOAMAX | 0.758 | 0.8408 | 0.951 | 0 | 0 | 0.124 | 0.81 | 4 | 3 | 4 |
| | | | LATDYN | 0.806 | 0.8343 | 0.9575 | 0 | 0 | 0.138 | 0.91 | 4 | 3 | 4 |
| | | | PLT | 0.844 | 0.9634 | 0.8283 | 0 | 0 | -0.152 | | | | |
| 45 | AZIMRMS | 0.9215 | LONDYN | 0.969 | 1.0815 | 0.7458 | 0 | 0 | -0.380 | 34.25 | 2 | 1 | 2 |
| | | | AOAMAX | 0.987 | 0.7149 | 1.1124 | 0 | 0 | 0.457 | 41.14 | 1 | 1 | 1 |
| | | | LATDYN | 0.801 | 1.0087 | 0.8187 | 0 | 0 | -0.210 | 18.93 | 3 | 1 | 3 |
| | | | PLT | 0.056 | 0.9187 | 0.9086 | 0 | 0 | -0.011 | | | | |

STEM 4 TEST 1 ANALYSIS F



STEM 4 TEST 1 ANALYSIS F

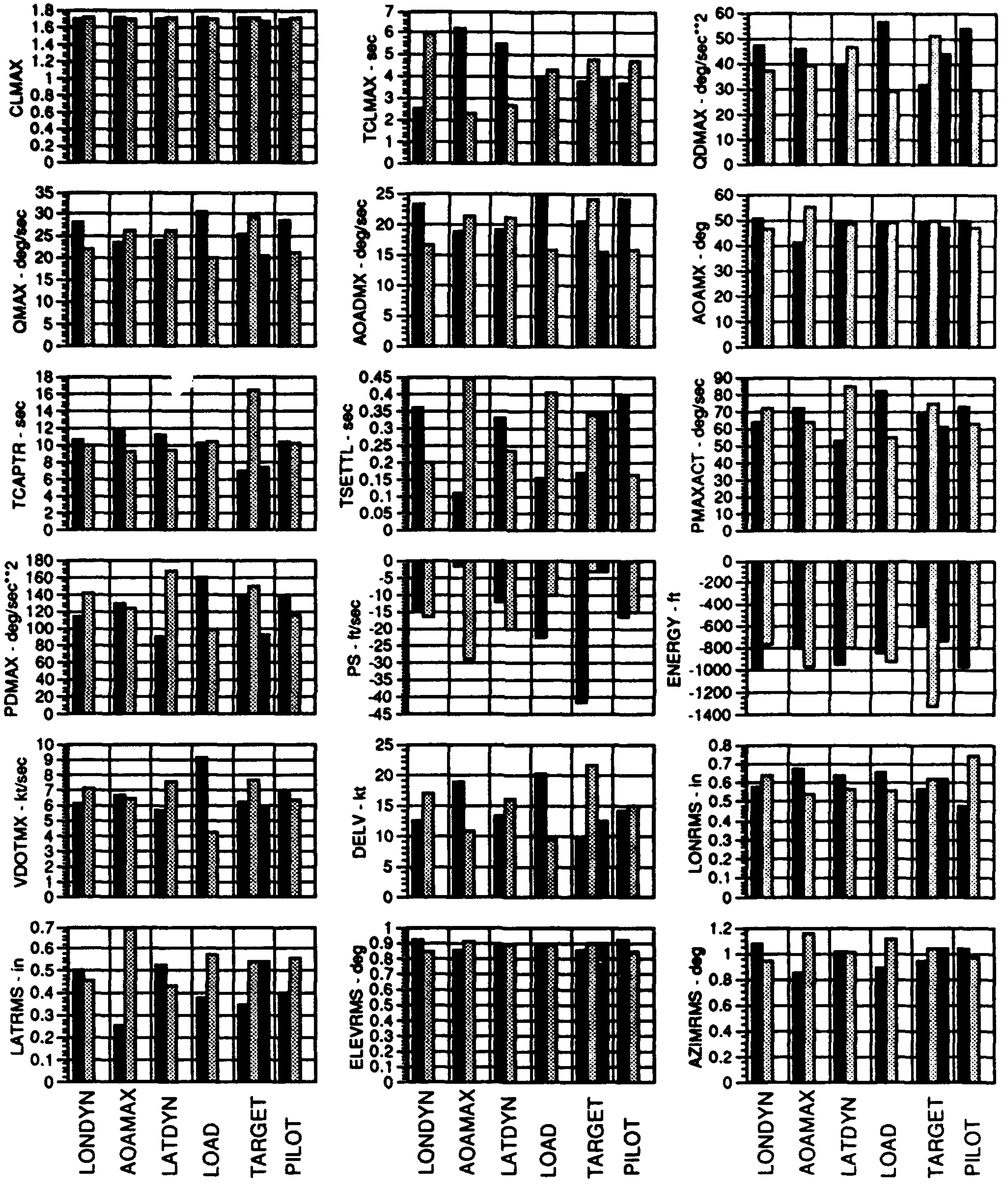


STEM 4 TEST 1 ANALYSIS G

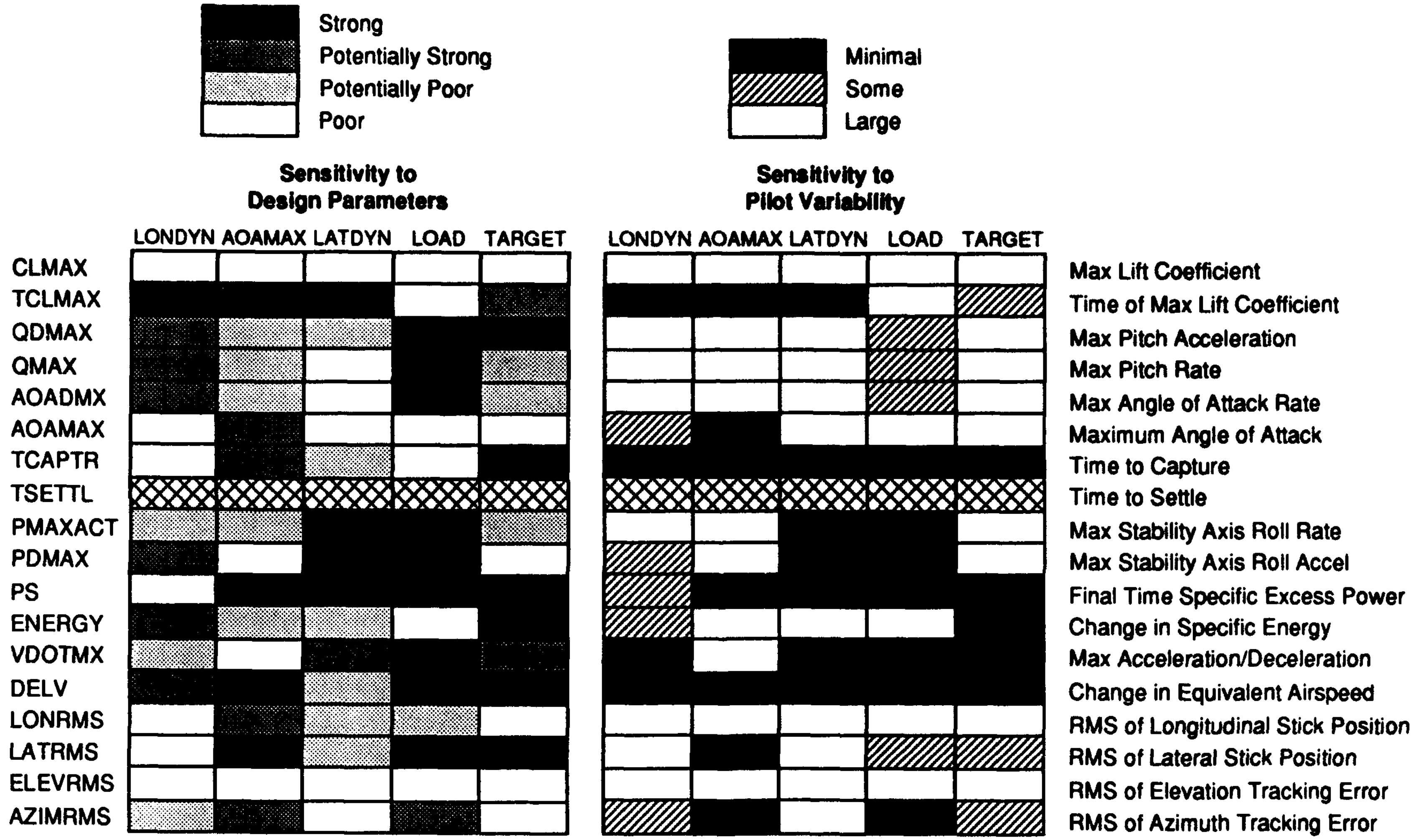
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | CLMAX | 0.0000 | LONDYN | 0.997 | 1.6982 | 1.7074 | 0 | 0 | 0.005 | 0.29 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 1.7181 | 1.6883 | 0 | 0 | -0.017 | 0.94 | 4 | 3 | 4 |
| | | | LATDYN | 1.000 | 1.6965 | 1.7092 | 0 | 0 | 0.007 | 0.40 | 4 | 3 | 4 |
| | | | LOAD | 1.000 | 1.7178 | 1.6885 | 0 | 0 | -0.017 | 0.92 | 4 | 3 | 4 |
| | | | TARGET | 1.000 | 1.7188 | 1.7189 | 1.67 | 0 | 0.000 | 0.00 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 1.6873 | 1.7191 | 0 | 0 | 0.019 | | | | |
| 3 | TCLMAX | 0 | LONDYN | 1.000 | 2.4999 | 5.9967 | 0 | 0 | 0.991 | 4.24 | 1 | 1 | 1 |
| | | | AOAMAX | 1.000 | 6.2082 | 2.3047 | 0 | 0 | -1.161 | 4.97 | 1 | 1 | 1 |
| | | | LATDYN | 1.000 | 5.5232 | 2.7215 | 0 | 0 | -0.768 | 3.29 | 1 | 1 | 1 |
| | | | LOAD | 0.988 | 4.018 | 4.3264 | 0 | 0 | 0.074 | 0.32 | 4 | 3 | 4 |
| | | | TARGET | 1.000 | 3.8036 | 4.8117 | 3.9198 | 0 | 0.237 | 1.02 | 2 | 2 | 3 |
| | | | PLT | 1.000 | 3.7138 | 4.6817 | 0 | 0 | 0.234 | | | | |
| 6 | QDMAX | 0.9999 | LONDYN | 1.000 | 46.834 | 37.234 | 0 | 0 | -0.231 | 0.36 | 2 | 3 | 4 |
| | | | AOAMAX | 1.000 | 45.794 | 38.932 | 0 | 0 | -0.163 | 0.25 | 3 | 3 | 4 |
| | | | LATDYN | 1.000 | 38.409 | 46.36 | 0 | 0 | 0.189 | 0.29 | 3 | 3 | 4 |
| | | | LOAD | 1.000 | 56.502 | 29.048 | 0 | 0 | -0.715 | 1.11 | 1 | 2 | 2 |
| | | | TARGET | 1.000 | 31.563 | 51.317 | 43.797 | 0 | 0.505 | 0.78 | 1 | 3 | 3 |
| | | | PLT | 1.000 | 54.021 | 29.448 | 0 | 0 | -0.645 | | | | |
| 8 | QMAX | 0 | LONDYN | 1.000 | 28.164 | 21.867 | 0 | 0 | -0.256 | 0.84 | 2 | 3 | 4 |
| | | | AOAMAX | 1.000 | 23.706 | 26.466 | 0 | 0 | 0.110 | 0.36 | 3 | 3 | 4 |
| | | | LATDYN | 1.000 | 23.939 | 26.444 | 0 | 0 | 0.100 | 0.33 | 4 | 3 | 4 |
| | | | LOAD | 1.000 | 30.55 | 20.149 | 0 | 0 | -0.428 | 1.40 | 1 | 2 | 2 |
| | | | TARGET | 1.000 | 25.572 | 29.281 | 20.572 | 0 | 0.136 | 0.44 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 28.727 | 21.257 | 0 | 0 | -0.306 | | | | |
| 11 | AOADMX | 0 | LONDYN | 1.000 | 23.213 | 16.577 | 0 | 0 | -0.343 | 0.79 | 2 | 3 | 4 |
| | | | AOAMAX | 1.000 | 18.76 | 21.197 | 0 | 0 | 0.122 | 0.28 | 3 | 3 | 4 |
| | | | LATDYN | 1.000 | 19.085 | 21.048 | 0 | 0 | 0.098 | 0.23 | 4 | 3 | 4 |
| | | | LOAD | 1.000 | 24.535 | 15.866 | 0 | 0 | -0.450 | 1.04 | 1 | 2 | 2 |
| | | | TARGET | 1.000 | 20.458 | 24.191 | 15.433 | 0 | 0.168 | 0.39 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 23.971 | 15.755 | 0 | 0 | -0.432 | | | | |
| 20 | AOAMX | 0 | LONDYN | 1.000 | 50.309 | 46.72 | 0 | 0 | -0.074 | 1.48 | 4 | 2 | 4 |
| | | | AOAMAX | 1.000 | 41.245 | 55.363 | 0 | 0 | 0.299 | 5.98 | 2 | 1 | 2 |
| | | | LATDYN | 0.999 | 48.591 | 48.581 | 0 | 0 | 0.000 | 0.00 | 4 | 3 | 4 |
| | | | LOAD | 0.815 | 48.125 | 49.012 | 0 | 0 | 0.018 | 0.37 | 4 | 3 | 4 |
| | | | TARGET | 1.000 | 49.199 | 49.525 | 47.035 | 0 | 0.007 | 0.13 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 49.75 | 47.326 | 0 | 0 | -0.050 | | | | |
| 25 | TCAPTR | 0 | LONDYN | 0.995 | 10.548 | 9.9079 | 0 | 0 | -0.063 | 3.97 | 4 | 1 | 4 |
| | | | AOAMAX | 1.000 | 11.499 | 9.079 | 0 | 0 | -0.239 | 15.11 | 2 | 1 | 2 |
| | | | LATDYN | 1.000 | 11.134 | 9.2735 | 0 | 0 | -0.184 | 11.64 | 3 | 1 | 3 |
| | | | LOAD | 0.850 | 10.07 | 10.398 | 0 | 0 | 0.032 | 2.03 | 4 | 1 | 4 |
| | | | TARGET | 1.000 | 6.9936 | 16.359 | 7.3698 | 0 | 0.956 | 60.55 | 1 | 1 | 1 |
| | | | PLT | 0.488 | 10.318 | 10.157 | 0 | 0 | -0.016 | | | | |
| 26 | TSETTL | 0.2123 | LONDYN | 0.708 | 0.3603 | 0.1972 | 0 | 0 | -0.640 | 0.64 | 4 | 3 | 4 |
| | | | AOAMAX | 0.967 | 0.1063 | 0.4442 | 0 | 0 | 1.971 | 1.99 | 1 | 2 | 2 |
| | | | LATDYN | 0.367 | 0.3263 | 0.234 | 0 | 0 | -0.338 | 0.34 | 4 | 3 | 4 |
| | | | LOAD | 0.865 | 0.1507 | 0.4032 | 0 | 0 | 1.151 | 1.16 | 2 | 2 | 3 |
| | | | TARGET | 0.421 | 0.168 | 0.339 | 0.339 | 0 | 0.761 | 0.77 | 4 | 3 | 4 |
| | | | PLT | 0.803 | 0.3917 | 0.1632 | 0 | 0 | -0.992 | | | | |
| 30 | PMAXACT | 0 | LONDYN | 1.000 | 63.644 | 71.816 | 0 | 0 | 0.121 | 0.85 | 3 | 3 | 4 |
| | | | AOAMAX | 1.000 | 71.466 | 63.967 | 0 | 0 | -0.111 | 0.78 | 3 | 3 | 4 |
| | | | LATDYN | 1.000 | 52.157 | 84.261 | 0 | 0 | 0.498 | 3.51 | 1 | 1 | 1 |
| | | | LOAD | 1.000 | 81.464 | 54.739 | 0 | 0 | -0.408 | 2.87 | 1 | 1 | 1 |
| | | | TARGET | 1.000 | 67.185 | 74.487 | 61.028 | 0 | 0.103 | 0.73 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 72.141 | 62.612 | 0 | 0 | -0.142 | | | | |

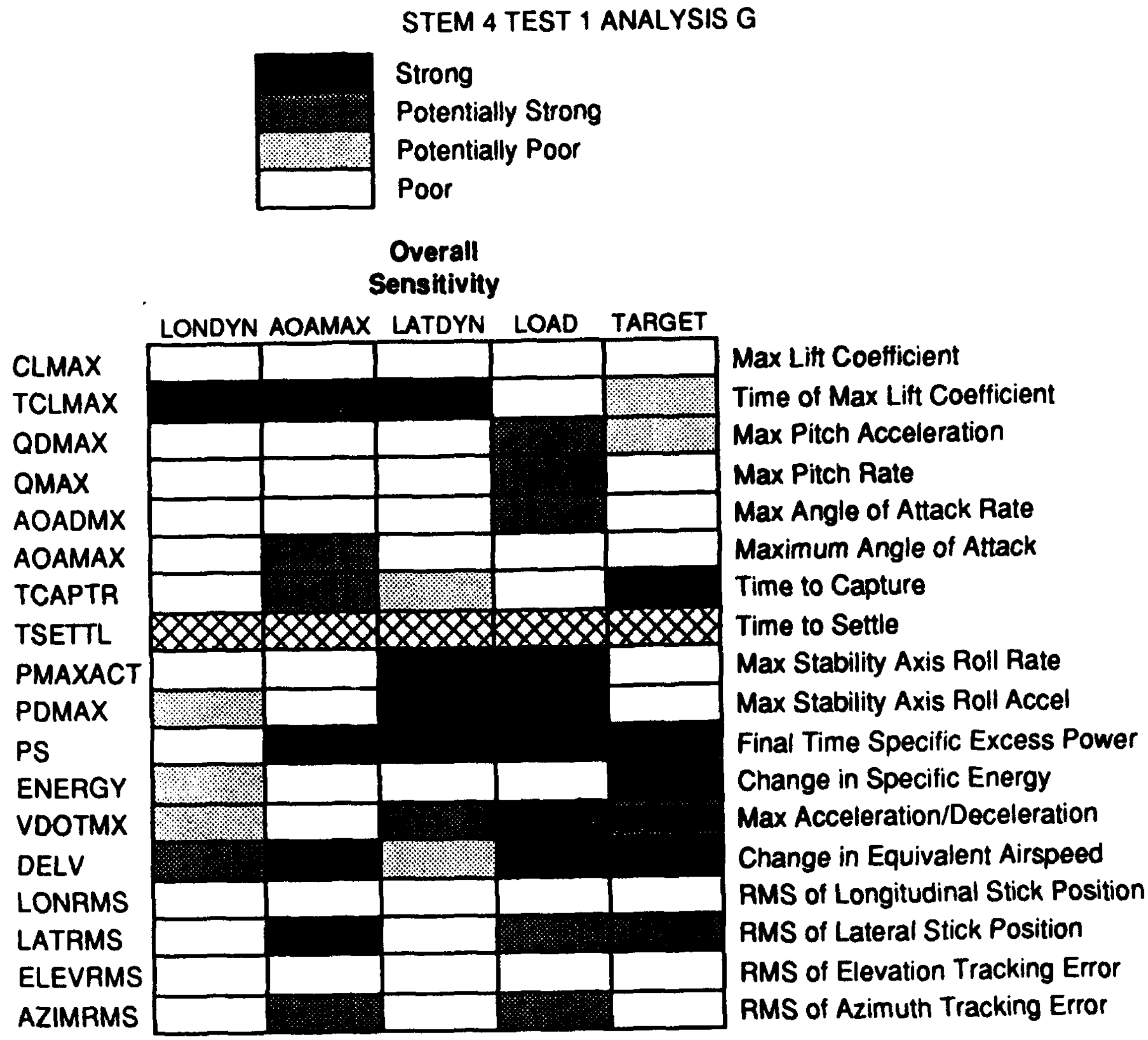
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 32 | PDMAX | 0.9999 | LONDYN | 1.000 | 112.91 | 140.46 | 0 | 0 | 0.220 | 1.23 | 2 | 2 | 3 |
| | | | AOAMAX | 0.859 | 130.08 | 122.49 | 0 | 0 | -0.060 | 0.33 | 4 | 3 | 4 |
| | | | LATDYN | 1.000 | 88.98 | 166.38 | 0 | 0 | 0.668 | 3.72 | 1 | 1 | 1 |
| | | | LOAD | 1.000 | 158.33 | 96.416 | 0 | 0 | -0.517 | 2.88 | 1 | 1 | 1 |
| | | | TARGET | 1.000 | 136.81 | 149.53 | 92.066 | 0 | 0.089 | 0.50 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 136.87 | 114.5 | 0 | 0 | -0.179 | | | | |
| 36 | PS | 0.9999 | LONDYN | 0.351 | -15.268 | -16.837 | 0 | 0 | -0.098 | 0.83 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | -1.5114 | -29.414 | 0 | 0 | -9.705 | 82.22 | 1 | 1 | 1 |
| | | | LATDYN | 0.992 | -12.029 | -20.346 | 0 | 0 | -0.550 | 4.66 | 1 | 1 | 1 |
| | | | LOAD | 1.000 | -22.538 | -10.005 | 0 | 0 | 0.904 | 7.66 | 1 | 1 | 1 |
| | | | TARGET | 1.000 | -41.753 | -3.1622 | -3.1472 | 0 | 6.564 | 55.61 | 1 | 1 | 1 |
| | | | PLT | 0.377 | -16.923 | -15.043 | 0 | 0 | 0.118 | | | | |
| 37 | ENERGY | 0 | LONDYN | 1.000 | -993.86 | -769.11 | 0 | 0 | 0.259 | 1.36 | 2 | 2 | 3 |
| | | | AOAMAX | 1.000 | -799.44 | -965.86 | 0 | 0 | -0.190 | 0.99 | 3 | 3 | 4 |
| | | | LATDYN | 1.000 | -961.48 | -804.2 | 0 | 0 | 0.180 | 0.94 | 3 | 3 | 4 |
| | | | LOAD | 0.985 | -849.25 | -919.89 | 0 | 0 | -0.080 | 0.42 | 4 | 3 | 4 |
| | | | TARGET | 1.000 | -589.75 | -1323.7 | -744.5 | 0 | -0.899 | 4.70 | 1 | 1 | 1 |
| | | | PLT | 1.000 | -966.26 | -799.02 | 0 | 0 | 0.191 | | | | |
| 38 | VDOTMX | 0.9999 | LONDYN | 0.963 | 6.0886 | 7.0156 | 0 | 0 | 0.142 | 2.08 | 3 | 1 | 3 |
| | | | AOAMAX | 0.311 | 6.6437 | 6.4319 | 0 | 0 | -0.032 | 0.47 | 4 | 3 | 4 |
| | | | LATDYN | 1.000 | 5.6511 | 7.4896 | 0 | 0 | 0.285 | 4.17 | 2 | 1 | 2 |
| | | | LOAD | 1.000 | 9.094 | 4.1701 | 0 | 0 | -0.861 | 12.57 | 1 | 1 | 1 |
| | | | TARGET | 0.998 | 6.2142 | 7.6476 | 5.7389 | 0 | 0.209 | 3.05 | 2 | 1 | 2 |
| | | | PLT | 0.896 | 6.7479 | 6.3014 | 0 | 0 | -0.069 | | | | |
| 39 | DELV | 0.9999 | LONDYN | 1.000 | 12.527 | 16.791 | 0 | 0 | 0.297 | 5.58 | 2 | 1 | 2 |
| | | | AOAMAX | 1.000 | 18.701 | 10.764 | 0 | 0 | -0.581 | 10.91 | 1 | 1 | 1 |
| | | | LATDYN | 0.998 | 13.258 | 15.999 | 0 | 0 | 0.189 | 3.55 | 3 | 1 | 3 |
| | | | LOAD | 1.000 | 20.115 | 9.4578 | 0 | 0 | -0.828 | 15.55 | 1 | 1 | 1 |
| | | | TARGET | 1.000 | 9.6108 | 21.682 | 12.428 | 0 | 0.906 | 17.01 | 1 | 1 | 1 |
| | | | PLT | 0.114 | 14.201 | 14.977 | 0 | 0 | 0.053 | | | | |
| 42 | LONRMS | 0.9999 | LONDYN | 0.977 | 0.5737 | 0.6331 | 0 | 0 | 0.099 | 0.21 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 0.675 | 0.535 | 0 | 0 | -0.234 | 0.51 | 2 | 3 | 4 |
| | | | LATDYN | 0.996 | 0.6344 | 0.5673 | 0 | 0 | -0.112 | 0.24 | 3 | 3 | 4 |
| | | | LOAD | 0.999 | 0.652 | 0.5562 | 0 | 0 | -0.160 | 0.35 | 3 | 3 | 4 |
| | | | TARGET | 0.855 | 0.5662 | 0.6202 | 0.6202 | 0 | 0.091 | 0.20 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 0.4739 | 0.7412 | 0 | 0 | 0.462 | | | | |
| 43 | LATRMS | 0.9999 | LONDYN | 0.754 | 0.5035 | 0.4524 | 0 | 0 | -0.107 | 0.33 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 0.2502 | 0.6902 | 0 | 0 | 1.198 | 3.66 | 1 | 1 | 1 |
| | | | LATDYN | 0.915 | 0.5242 | 0.43 | 0 | 0 | -0.199 | 0.61 | 3 | 3 | 4 |
| | | | LOAD | 1.000 | 0.3775 | 0.5727 | 0 | 0 | 0.429 | 1.31 | 1 | 2 | 2 |
| | | | TARGET | 1.000 | 0.3505 | 0.5433 | 0.5432 | 0 | 0.453 | 1.38 | 1 | 2 | 2 |
| | | | PLT | 1.000 | 0.4051 | 0.559 | 0 | 0 | 0.328 | | | | |
| 44 | ELEVRMS | 0.5977 | LONDYN | 0.926 | 0.9139 | 0.8441 | 0 | 0 | -0.080 | 0.83 | 4 | 3 | 4 |
| | | | AOAMAX | 0.822 | 0.8518 | 0.9068 | 0 | 0 | 0.063 | 0.65 | 4 | 3 | 4 |
| | | | LATDYN | 0.198 | 0.878 | 0.883 | 0 | 0 | 0.006 | 0.06 | 4 | 3 | 4 |
| | | | LOAD | 0.246 | 0.8719 | 0.8883 | 0 | 0 | 0.019 | 0.19 | 4 | 3 | 4 |
| | | | TARGET | 0.489 | 0.8487 | 0.8962 | 0.8963 | 0 | 0.055 | 0.57 | 4 | 3 | 4 |
| | | | PLT | 0.958 | 0.9207 | 0.8368 | 0 | 0 | -0.096 | | | | |
| 45 | AZIMRMS | 0.9948 | LONDYN | 0.949 | 1.0686 | 0.9391 | 0 | 0 | -0.130 | 1.85 | 3 | 2 | 4 |
| | | | AOAMAX | 1.000 | 0.8507 | 1.1502 | 0 | 0 | 0.306 | 4.37 | 2 | 1 | 2 |
| | | | LATDYN | 0.204 | 1.0059 | 1.007 | 0 | 0 | 0.001 | 0.02 | 4 | 3 | 4 |
| | | | LOAD | 0.997 | 0.8944 | 1.1098 | 0 | 0 | 0.218 | 3.10 | 2 | 1 | 2 |
| | | | TARGET | 0.618 | 0.9418 | 1.0387 | 1.0388 | 0 | 0.098 | 1.40 | 4 | 2 | 4 |
| | | | PLT | 0.537 | 1.0402 | 0.9698 | 0 | 0 | -0.070 | | | | |

STEM 4 TEST1 ANALYSIS G



STEM 4 TEST 1 ANALYSIS G




STEM 4 TEST 1 ANALYSIS G
Strong
Potentially Strong
Potentially Poor
Poor
Overall Sensitivity
LONDYN
AOAMAX
LATDYN
LOAD
TARGET
CLMAX
TCLMAX
QDMAX
QMAX
AOADMX
AOAMAX
TCAPTR
TSETTL
PMAXACT
PDMAX
PS
ENERGY
VDOTMX
DELV
LONRMS
LATRMS
ELEVRMS
AZIMRMS
Max Lift Coefficient
Time of Max Lift Coefficient
Max Pitch Acceleration
Max Pitch Rate
Max Angle of Attack Rate
Maximum Angle of Attack
Time to Capture
Time to Settle
Max Stability Axis Roll Rate
Max Stability Axis Roll Accel
Final Time Specific Excess Power
Change in Specific Energy
Max Acceleration/Deceleration
Change in Equivalent Airspeed
RMS of Longitudinal Stick Position
RMS of Lateral Stick Position
RMS of Elevation Tracking Error
RMS of Azimuth Tracking Error

STEM 4 TEST 1 (Loaded)
PILOT E
LONGITUDINAL CONFIGURATION 120
LATERAL CONFIGURATION 11

The angle of attack does not seem to be as high in this configuration. I have to pull the nose around a little bit for the first one. And for the second one, the loaded roll is fairly rapid and I overshot the second target and had to come back to it. It's a matter of kind of getting used to it. But that one was much faster. I have to lead the roll out to stop the loaded roll for the second target. I have to lead it with a lot of rudder and try to get it slowed down as it approaches the target so I don't overshoot. On the first capture, it seems like the pitch is fairly rapid and then I am maxing out on angle of attack I'm having to drag my velocity vector around to the guy. The capture is very easy because the pitch rate is slow at the end on the first target. Then on the loaded roll to the second target, the roll builds up very rapidly and it's a little difficult to control and stop at the second target. Lateral dynamics are a little bit squirrely at the end. I am using rudder and stick at the end to try to move the pipper around. I don't know if that's a good idea or not. It might be making it too sensitive. It's obvious it's rolling around the velocity vector and not the pipper. So, it's kind of a lateral directional combined task here. It makes it a little difficult to capture the target. The first capture is pretty much a pitch capture by the time you get there. The second one is more or less a lateral directional capture. This is a good task.

STEM 4 TEST 1 (Unloaded)
PILOT E
LONGITUDINAL CONFIGURATION 120
LATERAL CONFIGURATION 11

Because of the lateral directional stability, or the lack thereof, the capture is probably easier using the unloaded technique because you can roll, put him close to the velocity vector, and then it's a pitch capture task on the second one. You've got more time to get the lateral squared away as you're pulling the pipper up to the second target. It's kind of like the capture on the first target. The second capture becomes more of a pitch capture than lateral capture and that's an easier task with this configuration. Not easy, but easier. The pitch rate is fairly rapid on the angle of attack build up, while capturing the second target so it doesn't take long to get the nose up there and it doesn't give you a whole lot of time to get the lateral situation taken care of. You have a lot more time on the first one. I have a feeling that the unloaded roll is working better as far as the timing goes. But mainly it's because of making it easier to capture that second target in pitch.

STEM 4 TEST 1 (Loaded)
PILOT G
LONGITUDINAL CONFIGURATION 120
LATERAL CONFIGURATION 11

This has a nice quick roll around the velocity vector, but I can't track worth beans on this thing. Looks like I've got a good velocity vector roll capability, a good roll rate but outside of that its a very squirrelly configuration. I've got a good capability, it looks I can roll at least

around a 45-50 degree angle of attack cone but the roll rate is so quick it is very difficult to stop. It looks like my alpha and vector roll are optimized for a good 90 degree heading change. I just need to be able to stop the roll rate much better. You definitely don't want the second tracking task to be a lateral/directional task for this configuration. It doesn't look like a whole lot of pitch capability. I like the way I can bring the nose around there but its not very controllable. It looks like my pilot technique got better and better as I compensated for all of those bad flying qualities.

STEM 4 TEST 1 (Unloaded)
PILOT G
LONGITUDINAL CONFIGURATION 120
LATERAL CONFIGURATION 11

When I do the unloaded roll I need to spend a lot of time during the unload and the roll as I want to make sure I roll out with the lift vector pointed at that target to pull and acquire the target because if I'm off to the side I've got my work cut out for me to try to correct laterally. Its not quite as dynamic on the first target and you can set the wings pretty well. After the roll to the second target, I don't want to pull until I know I'm going to be right there. I can do a much better job of tracking if I keep it a longitudinal task versus a lateral/directional tracking task. It has a decent pitch rate capability, nothing too great.

STEM 4 TEST 1 (Loaded)
PILOT E
LONGITUDINAL CONFIGURATION 119
LATERAL CONFIGURATION 20

The dynamics are terrible on this one. Hell of an angle of attack. Okay, very sluggish lateral-directional characteristics on that one at high angle of attack. That time I tried to do a loaded roll into the first one and overshot it terribly. And the pitch capture is a little more difficult with this configuration also. Seems to be a little less damping in pitch. The nose really wants to slice around on the roll. Makes it very difficult to stop it where you want it laterally-directionally. I think this is going to be a real good task. You should be able to tell the difference in these configurations pretty easily. I'm having to ease off on the roll capability on the first target. I can't use all of the roll that I've got here or I will overshoot him badly...I guess the angle of attack is large enough on the second target that the roll does not build up to a very high rate so it's a little easier to stop it on the second target. The pitch stability is less. It seems to be less damped than the first configuration (longitudinal configuration 120) so there's bobbling in pitch going on in the capture. I'm using rudder and aileron on the rolls. You have to lead the roll out by a pretty good amount for the capture. You have to let out a lot of the roll as you're approaching the target and kind of sneak up on it or you'll overshoot.

STEM 4 TEST 1 (Unloaded)
PILOT E
LONGITUDINAL CONFIGURATION 119
LATERAL CONFIGURATION 20

The pitch rate build up on this thing is really rapid and then it slows down once it's reaching maximum. I'm just continually overshooting in roll when I try to do the unloaded roll. This becomes more or less a pitch capture task when you use the unloaded roll technique. The pitch capture is difficult because the pitch seems to be so lightly damped. It's kind of difficult to find that second target using this technique because things are moving around very rapidly and for some reason it's difficult to see. I'm having to roll kind of blind into the second target and guess at where he is for lift vector placement. This is one of those things where the agility gets in the way of capture. You can move the nose a lot faster than you can control it so it's a lighter nose and less damped configuration apparently. You can get the nose over there pretty quickly but then trying to capture something is difficult so you can't really use all the speed that you've got. You have to kind of sneak up on these guys. This second capture is difficult. The nose really wants to slice around even in a fairly unloaded situation.

STEM 4 TEST 1 (Loaded)
PILOT G
LONGITUDINAL CONFIGURATION 119
LATERAL CONFIGURATION 20

This is a little quicker in pitch. It would be nice if I could move the airplane around laterally. I have very poor lateral capability. It looks like I have a lot of alpha capability but it is not rolling all that fast and in fact, its very hard to control the roll. I'm going from stop to stop and its not nearly as responsive in roll as I would like it to be. This one is a challenge from a flying quality perspective. I might have a lot of pitch capability but it doesn't seem to be helping me out much in terms of flying the task. Now my goal is to try to be in the same plane so I don't have any lateral things to take care of. This is a huge, slow roll. It looks like full aft stick definitely gives you a much slower velocity vector roll to the second target. It doesn't look like you want to be much over 45 alpha in this configuration because the roll is so terrible. It doesn't track quite as well as the previous ones. The pitch handling qualities are not as stable as the previous configurations. I've got good pitch rate capability to get over to the target but if I don't control my lift vector well enough to where I need lateral adjustments when I get to the target it delays my capture. The key to this configuration is you can use a loaded roll but you don't want to use a full aft stick loaded roll. That's not going to optimize your performance. I could probably get the nose to the first target quicker if I wanted to but I've got much poorer flying qualities when I get there I can't control the lateral axis very well. The key is small inputs on the tracking, especially on the second tracking. When I was making bigger inputs at a little higher gain then I got the PIO.

STEM 4 TEST 1 (Unloaded)
PILOT G
LONGITUDINAL CONFIGURATION 119
LATERAL CONFIGURATION 20

Excellent pitch, I could yank and make the nose go quickly but I can't control it laterally when I do that. I can pull the nose real quick and get a good rate. I've got all kinds of angular reserve with this configuration. Its got an impressive pitch capability. The two seconds capture makes you work a whole lot harder than the one second and now I have to be careful how hard I pull to the second target so I don't overshoot it. All that ability to move the nose really starts to degrade the tracking capability if you make large inputs. I'm getting more use to knowing that this airplane has got almost a 90 degree angular reserve to where I can get my nose over there, but the problem is if I'm not right on target laterally/directionally, its going to take a while to get rid of that and then I don't want to go full aft stick to get the second target or I'll overshoot. I see significant lateral/directional problems in this airplane. The key is just how lucky you are in setting your wings to get it into a proper plane to pull to the target because if you are a little bit too far left or right you are going to have a terrible time trying to get that pipper back on to the target. Its going to be a little variable because a lot of it has to do with how well you make that initial setting of your lift vector when you pull over to the target. I can definitely see differences in the configurations of what you are giving me and they are affecting my piloting technique.

STEM 4 TEST 1 (Loaded)
PILOT E
LONGITUDINAL CONFIGURATION 126
LATERAL CONFIGURATION 20

Both the roll and the pitch is pretty poor. The tracking is much easier, everything is pretty highly damped. It is pretty easy to control. Everything happens in slow motion on this one. It has pretty poor pitch and roll capabilities and it is highly damped so it is pretty easy to track once you get there. The first one is pretty much a pitch capture and the second one if you use the full loaded roll technique will also turn into a pitch capture but a little more lateral-direction.

STEM 4 TEST 1 (Unloaded)
PILOT E
LONGITUDINAL CONFIGURATION 126
LATERAL CONFIGURATION 20

In the unloaded roll, the roll rate builds up considerably higher so it is harder to stop but there is plenty of time because you roll short of the target. There is plenty of time to get the lift vector lined up as you are pulling the nose back to the target, so its still pretty much of a pitch capture. This technique is probably a little faster with this configuration.

STEM 4 TEST 1 (Loaded)
PILOT G
LONGITUDINAL CONFIGURATION 126
LATERAL CONFIGURATION 20

I got kind of the worst of both worlds here. Its like poor pitch and poor roll (than longitudinal configuration 101, lateral configuration 11). The tracking is not too bad. The loaded roll is slow and easy to over shoot. I haven't seen much difference between this and the previous other than the roll characteristics. Its a much slower roll. I'm going from stop to stop in aileron to stop that roll. The loaded roll is very slow and I lead it significantly with full up aileron and then it turns into a pitch pointing task again. But it s easy to track with pitch. Very large aileron inputs required. It seems like this is pretty repeatable with these characteristics. As far as I can tell I am optimally performing the aircraft within its capabilities each time. There is not a lot of pilot technique involved.

STEM 4 TEST 1 (Unloaded)
PILOT G
LONGITUDINAL CONFIGURATION 126
LATERAL CONFIGURATION 20

I'm not seeing a whole lot of difference. I have been doing this whole thing with feet on the floor and I'll keep doing that since we're doing the data. With this configuration it feels like if my rudder is effective it might help me with my directional tracking. Same comments, poor pitch, poor roll, not much difference it didn't seem like between the unloaded roll versus the loaded roll

STEM 4 TEST 1 (Loaded)
PILOT E
LONGITUDINAL CONFIGURATION 101
LATERAL CONFIGURATION 11

The lateral dynamics are not as good on this one, but the angle of attack capability is still not too high. That means it takes a long time to drag the nose around there so there is usually time to get the lateral problem taken care of and turn it into a pitch capture task. I also overshoot it laterally pretty badly. I have to lead the roll out on the lateral pretty far to keep from over shooting. But because of the lower angle of attack for this particular task, I can still turn it into pretty much of a pitch capture task. I think that's what you would want to do with it because of the poor lateral damping would make capture difficult otherwise.

STEM 4 TEST 1 (Unloaded)
PILOT E
LONGITUDINAL CONFIGURATION 101
LATERAL CONFIGURATION 11

You probably don't gain much unloading on this one because the lateral dynamics are so bad it is hard to stop a high roll rate. Again, this is mostly a pitch capture, kind of a gross lateral capture early on for each of them. Dragging the velocity vector around takes so long that you really

don't have too much trouble getting the lateral squared away before you can get the pipper on them.

STEM 4 TEST 1 (Loaded)
PILOT G
LONGITUDINAL CONFIGURATION 101
LATERAL CONFIGURATION 11

I get about 45 degrees of heading change when I run out of my angular reserve and then I'm just pulling the velocity vector along. The tracking is fairly simple. It seems like a fairly limited airplane in terms of angle of attack or pitch rate capability. It is easy to track, I don't have high rates to work with. I like the vector roll. I tend to overshoot the roll but I've got all kinds of time to get into the right plane before I begin my tracking. About the highest AOA that I have seen is 35. I'm fairly pleased with the task. This one has turned into a pitch pointing task for the second capture even with the loaded roll because you have so much time between when you roll over to that target until you actually acquire it that you are now working with a single plane.

STEM 4 TEST 1 (Unloaded)
PILOT G
LONGITUDINAL CONFIGURATION 101
LATERAL CONFIGURATION 11

What a pig. I'm not seeing an appreciable difference here. Its hard to get a good feel for the unload since my body is not moving. Say, are you guys using a calendar to time this task? It doesn't look like I've got an appreciable difference between the unload and the loaded roll for the second capture. It may be a little quicker with the unloaded roll. It seems like I'm able to somehow maintain a greater pitch reserve using the unloaded roll but its probably just appears that way because I unload to such a low angle of attack during the unload that it appears that I have a lot better pitch capability as I move my nose back to the angle of attack limit. Once again it is easy to track the first target. Then I unload and roll and then as I pull, it feels like I've got good pitch capability. It doesn't seem like I'm dragging the velocity vector quite as long when I use the unloaded roll but that's just perception. It looks like its probably very close to the same as using the loaded technique. Overall an easy tracking task with this configuration but very, very slow pitch capability.

STEM 4 TEST 2
PILOT G
MUSIC CONFIGURATION
PST ON

A little bit quicker finding them. And now a little jumpy. If I try to track him wings level it is usually the best. Now I am just using pitch, coming back around because the pitch is a little bit faster. Try to track. A tendency to undershoot. So now I am just yawing my way between the two guys. When I get in close, take the rudder out to bring the nose back up. Very easy to track. Really not that nose high either. I use the rudder pretty much until I get my lift vector on the guy and then I pull up. This is a much easier airplane to track with. The very first track is a little bit difficult, I think because of the high air speed--it seems fairly PIO prone. There is a real tendency to undershoot once you take the back pressure off after the initial acquisition. I am using just a straight pitch pull on the first acquisition since I am at a fairly low alpha. When I try to track I get a lot of wobbles everywhere. I do my best tracking at about wings level. So it seems PST-ON, I have tried to break the acquisitions into two separate maneuvers. There is a rudder initial move to rotate my airplane body across to put the lift vector on the guy; and then I just use pitch to bring my nose back up to him. Very stable tracking at the slow air speed. Fast air speed it is real bobbly.

STEM 4 TEST 2
PILOT G
MUSIC CONFIGURATION
PST OFF

I am trying to use rudder and it really slung the airplane around, but the last 45° of turn or so, it is slow - but it is smooth. But then when I get it right in the acquisition I try to relax the back pressure and I undershoot. Stomp on the rudder, bring the stick aft, come off the rudder as I hit the horizon and now I am waiting for the nose to track around, wait, wait, wait, wait, wait. Good acquisition. Actually I am getting pretty good at tracking right now it seems like - it is a slower air speed. Maybe the high air speed is just so sensitive. It is probably over sensitive with the higher air speed. The rudder is kind of nice at the higher angle of attack. It keeps you from having to wait so long on the pull.

## Data Contents for STEM 5: Rolling Defense

TEST 1: Maneuver tested at AOA≈38°

- Summary of Design Parameter Variations Tested
- Numerical Summary of Statistical Analysis
- Bar Graphs of Measures of Merit
- Design Parameter Correlations, Pilot Variability, and Overall Correlations
- Pilot Comments

TEST 2: Maneuver tested at AOA≈40°, V≈160 KEAS

- Summary of Design Parameter Variations Tested
- Numerical Summary of Statistical Analysis
- Bar Graphs of Measures of Merit
- Design Parameter Correlations, Pilot Variability, and Overall Correlations
- Pilot Comments

## Summary of Design Parameters Tested for STEM 5 TEST 1

Test variables:

PMAX: Indicates the maximum stability axis roll rate available from a full stick input. Directly affects the amount of inertia coupling present:

(-) 80 deg/sec

(+) 140 deg/sec

TV: Controls whether or not pitch thrust vectoring was enabled:

(-) No vectoring, results in aerodynamic control power being used for inertia coupling and the nose down pilot input

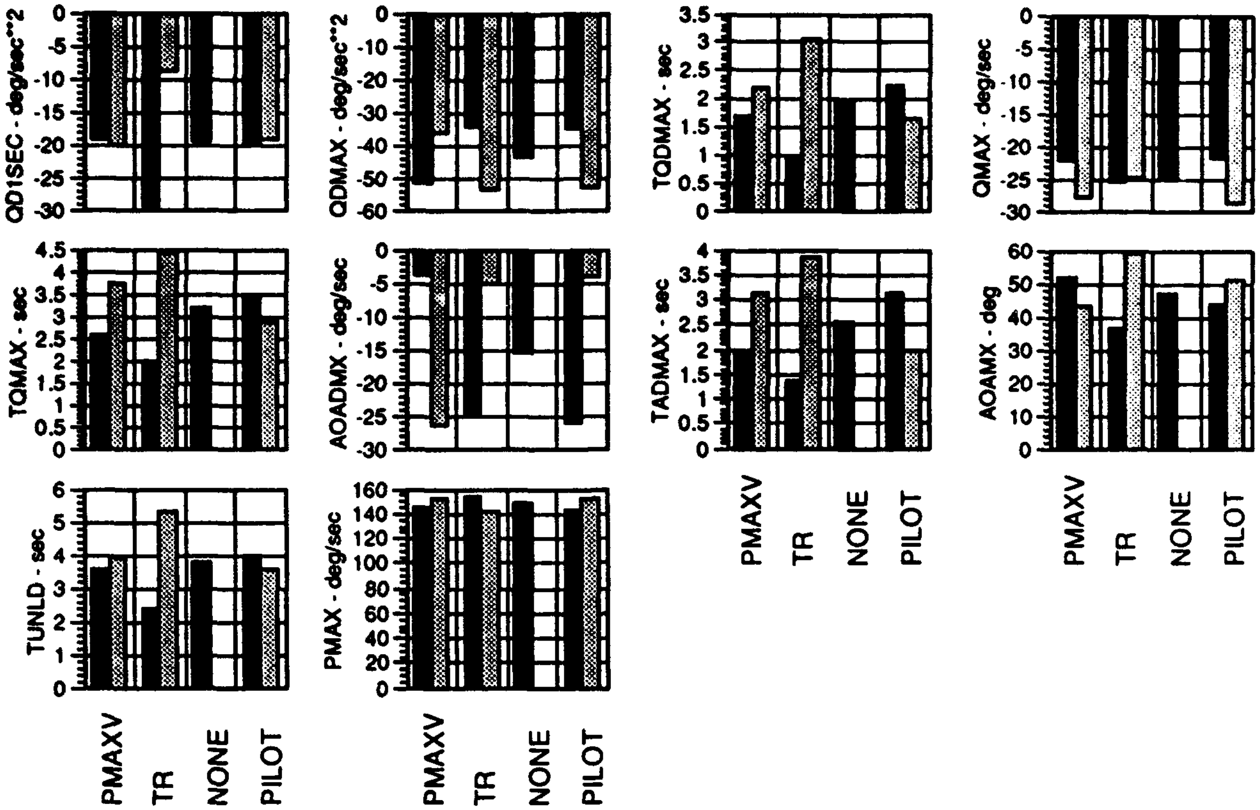
(+) With vectoring, increases nose-down control power available

### Test Matrix

| Lon Config | Lat Config | PMAX | TV |
|---|---|---|---|
| 128 | 18 | 80°/sec (-) | Off (-) |
| 128 | 19 | 140°/sec (+) | Off (-) |
| 127 | 18 | 80°/sec (-) | On (+) |
| 127 | 19 | 140°/sec (+) | On (+) |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ### | QD1SEC | 0.9999 | PMAXV | 0.289 | -19.03 | -20.04 | 0 | 0 | -0.052 | 1.21 | 4 | 2 | 4 |
| | | | TR | 1.000 | -29.58 | -8.696 | 0 | 0 | 1.554 | 36.32 | 1 | 1 | 1 |
| | | | PLT | 0.007 | -19.96 | -19.12 | 0 | 0 | 0.043 | | | | |
| 6 | QDMAX | 0.9995 | PMAXV | 0.982 | -51.36 | -36.09 | 0 | 0 | 0.360 | 0.83 | 2 | 3 | 4 |
| | | | TR | 0.995 | -34.22 | -53.38 | 0 | 0 | -0.459 | 1.06 | 1 | 2 | 2 |
| | | | PLT | 0.990 | -34.74 | -52.82 | 0 | 0 | -0.431 | | | | |
| 7 | TQDMAX | 0.996 | PMAXV | 0.558 | 1.6782 | 2.2233 | 0 | 0 | 0.285 | 0.95 | 4 | 3 | 4 |
| | | | TR | 0.993 | 0.961 | 3.0457 | 0 | 0 | 1.427 | 4.73 | 1 | 1 | 1 |
| | | | PLT | 0.626 | 2.2376 | 1.6626 | 0 | 0 | -0.301 | | | | |
| 8 | QMAX | 0.2629 | PMAXV | 0.489 | -22.24 | -27.83 | 0 | 0 | -0.226 | 0.84 | 4 | 3 | 4 |
| | | | TR | 0.019 | -25.35 | -24.94 | 0 | 0 | 0.016 | 0.06 | 4 | 3 | 4 |
| | | | PLT | 0.583 | -21.93 | -28.63 | 0 | 0 | -0.270 | | | | |
| 9 | TQMAX | 0.9997 | PMAXV | 0.913 | 2.574 | 3.7271 | 0 | 0 | 0.379 | 1.96 | 2 | 2 | 3 |
| | | | TR | 0.999 | 1.9918 | 4.454 | 0 | 0 | 0.894 | 4.62 | 1 | 1 | 1 |
| | | | PLT | 0.682 | 3.4646 | 2.8585 | 0 | 0 | -0.193 | | | | |
| 11 | AOADMX | 0.9999 | PMAXV | 0.997 | -3.788 | -26.32 | 0 | 0 | -3.402 | 1.07 | 1 | 2 | 2 |
| | | | TR | 0.989 | -24.98 | -5.243 | 0 | 0 | 2.277 | 0.71 | 1 | 3 | 3 |
| | | | PLT | 0.994 | -26.13 | -4 | 0 | 0 | 3.189 | | | | |
| 12 | TADMAX | 0.9994 | PMAXV | 0.883 | 1.9865 | 3.1194 | 0 | 0 | 0.467 | 0.99 | 2 | 3 | 4 |
| | | | TR | 0.998 | 1.3803 | 3.8707 | 0 | 0 | 1.224 | 2.61 | 1 | 1 | 1 |
| | | | PLT | 0.900 | 3.1223 | 1.9835 | 0 | 0 | -0.469 | | | | |
| 20 | AOAMX | 0.9996 | PMAXV | 0.888 | 51.896 | 43.039 | 0 | 0 | -0.188 | 1.24 | 4 | 2 | 4 |
| | | | TR | 0.999 | 36.688 | 58.776 | 0 | 0 | 0.489 | 3.21 | 1 | 1 | 1 |
| | | | PLT | 0.730 | 43.841 | 51.028 | 0 | 0 | 0.152 | | | | |
| ### | TUNLD | 0.9995 | PMAXV | 0.349 | 3.6032 | 3.9194 | 0 | 0 | 0.084 | 0.74 | 4 | 3 | 4 |
| | | | TR | 1.000 | 2.3726 | 5.279 | 0 | 0 | 0.888 | 7.80 | 1 | 1 | 1 |
| | | | PLT | 0.544 | 3.9723 | 3.546 | 0 | 0 | -0.114 | | | | |
| ### | PMAX | 0.9337 | PMAXV | 0.810 | 144.26 | 151.51 | 0 | 0 | 0.049 | 0.76 | 4 | 3 | 4 |
| | | | TR | 0.974 | 154.35 | 141.18 | 0 | 0 | -0.089 | 1.38 | 4 | 2 | 4 |
| | | | PLT | 0.934 | 143.41 | 153.03 | 0 | 0 | 0.065 | | | | |

STEM 5 TEST 1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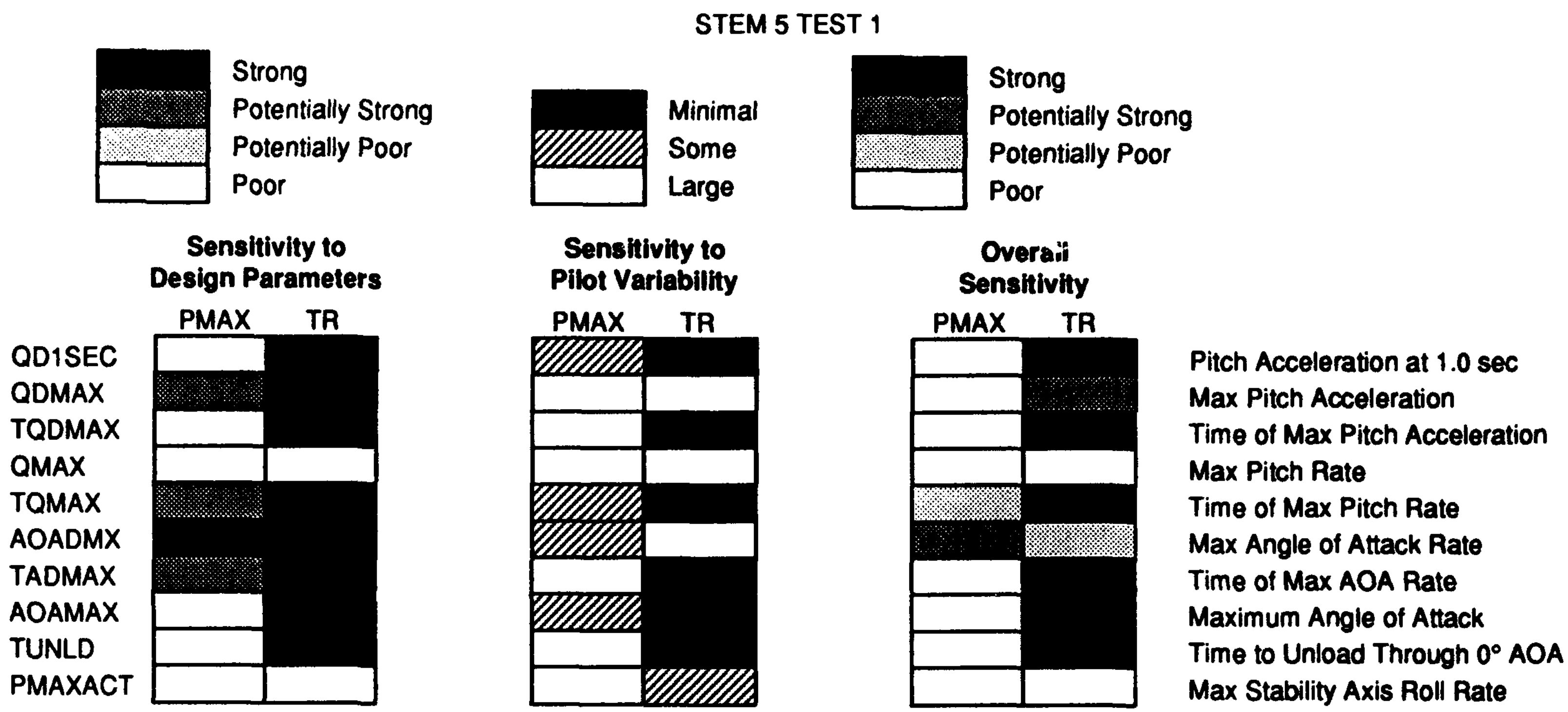
QDMAX - deg/sec**2
TQDMAX - sec
QMAX - deg/sec
TQMAX - sec
AOADMX - deg/sec
TADMAX - sec
AOAMX - deg
TUNLD - sec
PMAX - deg/sec
PMAXV
TR
NONE
PILOT


STEM 5 TEST 1
Strong
Potentially Strong
Potentially Poor
Poor
Minimal
Some
Large
Strong
Potentially Strong
Potentially Poor
Poor
Sensitivity to Design Parameters
Sensitivity to Pilot Variability
Overall Sensitivity
PMAX
TR
QD1SEC
QDMAX
TQDMAX
QMAX
TQMAX
AOADMX
TADMAX
AOAMAX
TUNLD
PMAXACT
Pitch Acceleration at 1.0 sec
Max Pitch Acceleration
Time of Max Pitch Acceleration
Max Pitch Rate
Time of Max Pitch Rate
Max Angle of Attack Rate
Time of Max AOA Rate
Maximum Angle of Attack
Time to Unload Through 0° AOA
Max Stability Axis Roll Rate

PILOT C
LONGITUDINAL CONFIGURATION 127
LATERAL CONFIGURATION 19

I think I'm going to probably want to start that roll a little bit above 200 knots. The controls are squirrelly. It looked like the angle of attack hung up on me there. It departs if I also use full rudder. I think part of that is that the pitch coupling is going to be aggravated as you are coming through the last 90 degrees of bank. In other words ±90 degrees of bank. I'm not really coupling up on the initial roll. It doesn't couple until I start the nose down. I guess the roll rate picks up as the angle of attack come down. So I'm not coupling during the roll. I'm coupling when I unload. We've got enough to maintain the roll rate at 36 degrees AOA, but as the angle of attack starts coming down then that roll rate must pick up fairly rapidly and then it lets go. That would catch you by surprise. That would be a real nasty characteristic. I think without rudder it's going to be a little sensitive to where you are in a roll when you unload. This characteristic might be real. It's something you ought to be able to manage with the flight control system certainly, but it's something you definitely wouldn't want to build in an airplane.

STEM 5 TEST 1
PILOT E
LONGITUDINAL CONFIGURATION 127
LATERAL CONFIGURATION 19

I can tell this one is a lot squirrlier. This one does not want to unload. Yahoo. That one had pretty good roll, but did not unload and eventually departed once it did unload. It just flat plates, then goes negative and departs.

**Summary of Design Parameters Tested for STEM 5 TEST 2**

Test variables:

PMAX: Indicates the maximum stability axis roll rate available from a full stick input. Directly affects the amount of inertia coupling present:

(-) 30.0 deg/sec, approximate value obtainable at 40° AOA and 160 KEAS

(+) 60.0 deg/sec, approximate value obtainable at 40° AOA and 160 KEAS

DCG: Indicates variations in center of gravity location in %MAC.

2.77% (-), CG position aft of nominal results in reduced nose-down control power

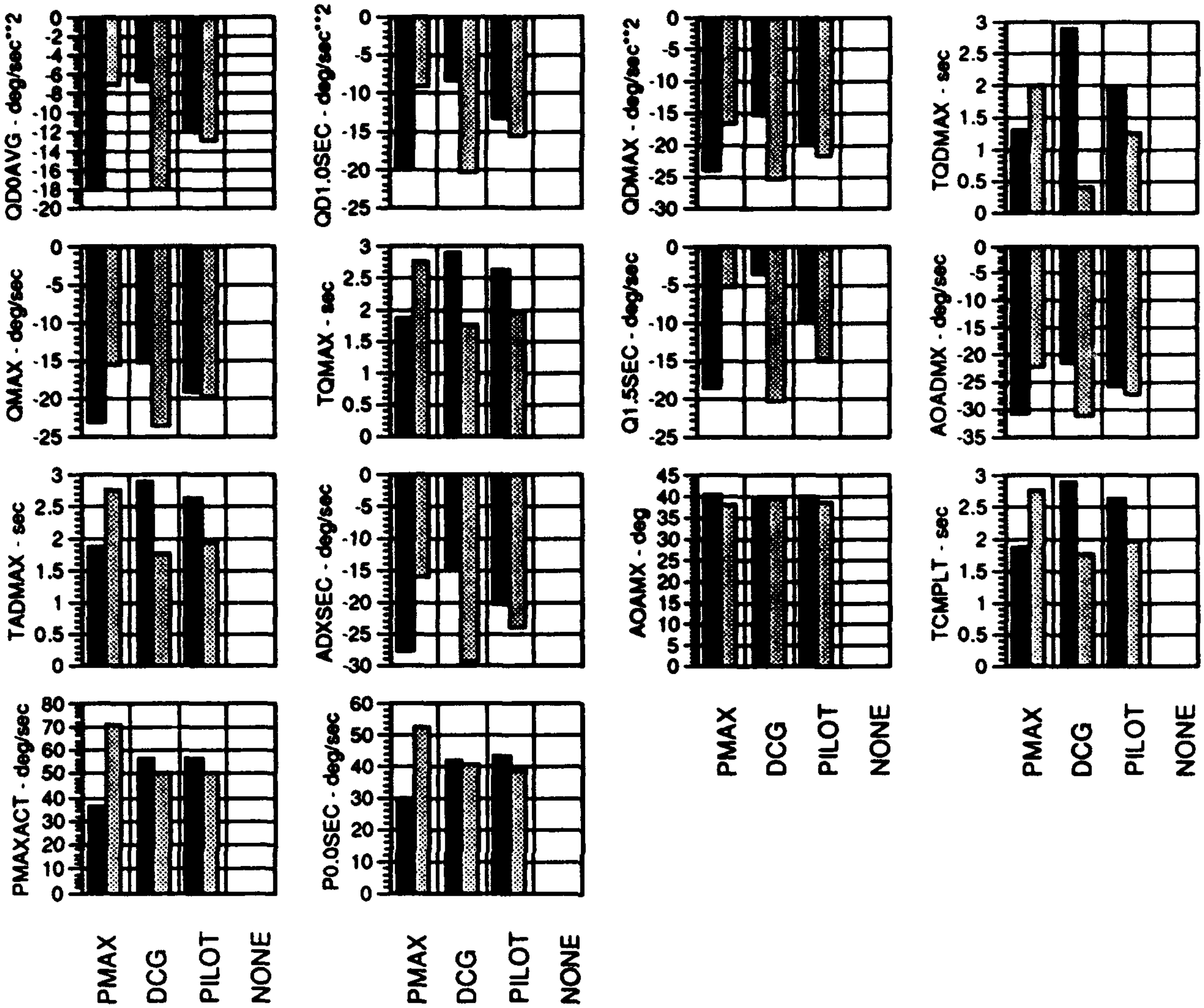
-3.46% (+), CG position forward of nominal results in increased nose-down control power

**Test Matrix (Full Factorial, Pilots A, F)**

| Lon Config | Lat Config | PMAX | DCG |
|---|---|---|---|
| 147 | 36 | 30°/sec (-) | 2.77 (-) |
| 147 | 37 | 60°/sec (+) | 2.77 (-) |
| 145 | 36 | 30°/sec (-) | -3.46 (+) |
| 145 | 37 | 60°/sec (+) | -3.46 (+) |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | QD0AVG | 0.9999 | PMAX | 1.000 | -17.76 | -7.085 | 0 | 0 | 1.054 | 15.27 | 1 | 1 | 1 |
| | (1.0 sec) | | DCG | 1.000 | -6.681 | -18.16 | 0 | 0 | -1.175 | 17.04 | 1 | 1 | 1 |
| | | | PLT | 0.840 | -12.03 | -12.89 | 0 | 0 | -0.069 | | | | |
| 5 | QDXSEC | 0.9999 | PMAX | 1.000 | -19.69 | -9.141 | 0 | 0 | 0.845 | 5.55 | 1 | 1 | 1 |
| | (1.0 sec) | | DCG | 1.000 | -8.514 | -20.32 | 0 | 0 | -0.984 | 6.46 | 1 | 1 | 1 |
| | | | PLT | 0.052 | -13.43 | -15.62 | 0 | 0 | -0.152 | | | | |
| 6 | QDMAX | 0.9999 | PMAX | 1.000 | -24.07 | -16.84 | 0 | 0 | 0.364 | 2.93 | 2 | 1 | 2 |
| | | | DCG | 1.000 | -15.34 | -25.57 | 0 | 0 | -0.534 | 4.29 | 1 | 1 | 1 |
| | | | PLT | 0.464 | -19.31 | -21.86 | 0 | 0 | -0.125 | | | | |
| 7 | TQDMAX | 0.9999 | PMAX | 0.961 | 1.277 | 1.9881 | 0 | 0 | 0.457 | 0.97 | 1 | 3 | 3 |
| | | | DCG | 1.000 | 2.8793 | 0.3858 | 0 | 0 | -3.665 | 7.74 | 1 | 1 | 1 |
| | | | PLT | 0.778 | 1.9556 | 1.2377 | 0 | 0 | -0.474 | | | | |
| 8 | QMAX | 0.9999 | PMAX | 1.000 | -23.14 | -15.78 | 0 | 0 | 0.393 | 12.31 | 2 | 1 | 2 |
| | | | DCG | 1.000 | -15.29 | -23.63 | 0 | 0 | -0.449 | 14.09 | 1 | 1 | 1 |
| | | | PLT | 0.917 | -19.18 | -19.8 | 0 | 0 | -0.032 | | | | |
| 9 | TQMAX | 0.9933 | PMAX | 0.984 | 1.8672 | 2.7553 | 0 | 0 | 0.399 | 1.33 | 2 | 2 | 3 |
| | | | DCG | 0.996 | 2.8793 | 1.7431 | 0 | 0 | -0.523 | 1.74 | 1 | 2 | 2 |
| | | | PLT | 0.837 | 2.6129 | 1.9426 | 0 | 0 | -0.301 | | | | |
| 10 | QXSEC | 0.9999 | PMAX | 1.000 | -18.77 | -5.246 | 0 | 0 | 1.650 | 3.78 | 1 | 1 | 1 |
| | (1.5 sec) | | DCG | 1.000 | -3.594 | -20.43 | 0 | 0 | -2.754 | 6.31 | 1 | 1 | 1 |
| | | | PLT | 0.848 | -9.705 | -14.83 | 0 | 0 | -0.437 | | | | |
| 11 | AOADMX | 0.9999 | PMAX | 1.000 | -30.79 | -22.15 | 0 | 0 | 0.336 | 6.73 | 2 | 1 | 2 |
| | | | DCG | 1.000 | -21.61 | -31.33 | 0 | 0 | -0.380 | 7.62 | 2 | 1 | 2 |
| | | | PLT | 0.715 | -25.87 | -27.2 | 0 | 0 | -0.050 | | | | |
| 12 | TADMAX | 0.9934 | PMAX | 0.985 | 1.8623 | 2.7553 | 0 | 0 | 0.402 | 1.32 | 1 | 2 | 2 |
| | | | DCG | 0.997 | 2.8793 | 1.7382 | 0 | 0 | -0.526 | 1.73 | 1 | 2 | 2 |
| | | | PLT | 0.841 | 2.6129 | 1.9371 | 0 | 0 | -0.304 | | | | |
| 13 | ADXSEC | 0.9999 | PMAX | 1.000 | -27.96 | -16.28 | 0 | 0 | 0.568 | 3.33 | 1 | 1 | 1 |
| | (1.5 sec) | | DCG | 1.000 | -14.74 | -29.49 | 0 | 0 | -0.751 | 4.40 | 1 | 1 | 1 |
| | | | PLT | 0.703 | -20.42 | -24.19 | 0 | 0 | -0.171 | | | | |
| 20 | AOAMX | 0.9924 | PMAX | 0.982 | 40.422 | 37.68 | 0 | 0 | -0.070 | 1.91 | 4 | 2 | 4 |
| | | | DCG | 0.313 | 38.845 | 39.257 | 0 | 0 | 0.011 | 0.29 | 4 | 3 | 4 |
| | | | PLT | 0.897 | 39.695 | 38.264 | 0 | 0 | -0.037 | | | | |
| 27 | TCMPLT | 0.9933 | PMAX | 0.984 | 1.8672 | 2.7553 | 0 | 0 | 0.399 | 1.33 | 2 | 2 | 3 |
| | | | DCG | 0.996 | 2.8793 | 1.7431 | 0 | 0 | -0.523 | 1.74 | 1 | 2 | 2 |
| | | | PLT | 0.837 | 2.6129 | 1.9426 | 0 | 0 | -0.301 | | | | |
| 30 | PMAXACT | 0.9999 | PMAX | 1.000 | 35.985 | 70.653 | 0 | 0 | 0.727 | 6.17 | 1 | 1 | 1 |
| | | | DCG | 1.000 | 56.182 | 50.457 | 0 | 0 | -0.108 | 0.91 | 3 | 3 | 4 |
| | | | PLT | 0.937 | 56.118 | 49.898 | 0 | 0 | -0.118 | | | | |
| 46 | PXSEC | 0.9999 | PMAX | 1.000 | 29.947 | 52.268 | 0 | 0 | 0.586 | 5.08 | 1 | 1 | 1 |
| | (0.0 sec) | | DCG | 0.945 | 41.92 | 40.295 | 0 | 0 | -0.040 | 0.34 | 4 | 3 | 4 |
| | | | PLT | 0.989 | 43.224 | 38.521 | 0 | 0 | -0.115 | | | | |

STEM 5 TEST 2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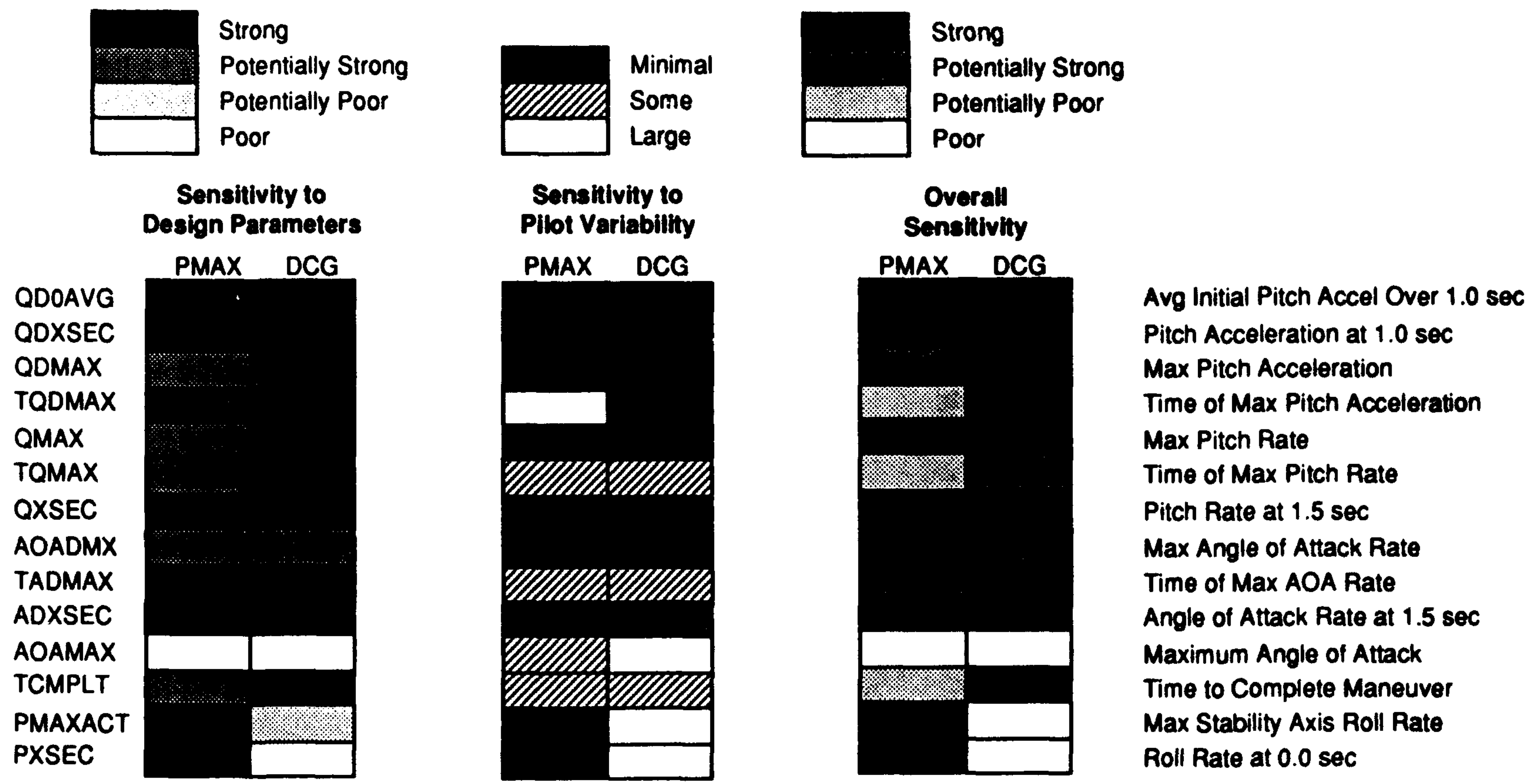
QD1.0SEC - deg/sec**2
QDMAX - deg/sec**2
TQDMAX - sec
QMAX - deg/sec
TQMAX - sec
Q1.5SEC - deg/sec
AOADMX - deg/sec
TADMAX - sec
ADXSEC - deg/sec
AOAMX - deg
TCMPLT - sec
PMAXACT - deg/sec
P0.0SEC - deg/sec
PMAX
DCG
PILOT
NONE

STEM 5 TEST 2


Strong
Potentially Strong
Potentially Poor
Poor
Minimal
Some
Large
Strong
Potentially Strong
Potentially Poor
Poor
Sensitivity to Design Parameters
Sensitivity to Pilot Variability
Overall Sensitivity
PMAX
DCG
PMAX
DCG
PMAX
DCG
QD0AVG
QDXSEC
QDMAX
TQDMAX
QMAX
TQMAX
QXSEC
AOADMX
TADMAX
ADXSEC
AOAMAX
TCMPLT
PMAXACT
PXSEC
Avg Initial Pitch Accel Over 1.0 sec
Pitch Acceleration at 1.0 sec
Max Pitch Acceleration
Time of Max Pitch Acceleration
Max Pitch Rate
Time of Max Pitch Rate
Pitch Rate at 1.5 sec
Max Angle of Attack Rate
Time of Max AOA Rate
Angle of Attack Rate at 1.5 sec
Maximum Angle of Attack
Time to Complete Maneuver
Max Stability Axis Roll Rate
Roll Rate at 0.0 sec

STEM 5 TEST 1
PILOT C
LONGITUDINAL CONFIGURATION 128
LATERAL CONFIGURATION 18

Roll is too slow. You have a fairly steep ramp on that roll rate with angle of attack, but that's not all that unusual. We don't have any coupling problems. Let me try and start that roll at a little faster speed because this thing is rolling so much slower. Well I almost got 180 degrees of roll out of that one. So perhaps starting at 250 knots would get you a little bit on your back. Definitely too slow on a roll.

STEM 5 TEST 1
PILOT E
LONGITUDINAL CONFIGURATION 128
LATERAL CONFIGURATION 18

I was a little late getting the forward stick into that one. It unloaded it okay. It unloads fine. This configuration is pretty slow in the roll at 36 degrees alpha. I don't think the wings barely got back to level by the time I hit 170 knots, if they even made it that far. So it's a very slow onset of the roll rate at high alpha, but it does unload fairly quickly. I don't even get 90 degrees of roll out of it before it goes from 200 knots to 170 knots.

STEM 5 TEST 1
PILOT C
LONGITUDINAL CONFIGURATION 128
LATERAL CONFIGURATION 19

It's a pretty spiffy roll rate. And it took me less than 3 seconds to unload. Rolls pretty nice, it is well behaved. If anything, it is a little underdamped because I pitched up to about 42 degrees. It took about the same time to load as it took me to unload. On that one I think I would object to is the low pitch onset rates at the high speed (limited in g). At the low speeds it looks like the damping is a little bit low. The roll is spectacular at that low speed. There's nothing unpleasant in roll.

STEM 5 TEST 1
PILOT E
LONGITUDINAL CONFIGURATION 128
LATERAL CONFIGURATION 19

That one is not much different than the last one (than longitudinal configuration 128/lateral configuration 18). The roll may be a little better in the last one. The unload is about the same.

STEM 5 TEST 1
PILOT C
LONGITUDINAL CONFIGURATION 127
LATERAL CONFIGURATION 18

It's coupling a little bit. That roll rate really sped up as that angle of attack got down around 5 degrees. The alpha limits just below Clmax.

Well, it's oscillatory. It couples slightly during the roll. It goes from around 34 or 35 degrees up to about 38. But it does come down.

STEM 5 TEST 1
PILOT E
LONGITUDINAL CONFIGURATION 127
LATERAL CONFIGURATION 18

Pretty sluggish in roll but it unloads pretty quickly.

STEM 5 TEST 1
STEM 5 TEST 2
PILOT A
LONGITUDINAL CONFIGURATION 147
LATERAL CONFIGURATION 37

A little bit sluggish in pitch response, but considering everything that's going on, it looks like we have enough control power to make something happen there anyway. Even in the simulator where there's no turbulence, no wing rock, no other problems, these are just about the limit of pilot ability. It's going to be interesting to see what the TPS results are like out of this. It looked like pretty sluggish pitch response because I had such a rate going that it took a while for the stab to get my nose back down. Big roll rate on that one. The nose really slings over. I'm ending up with a very good roll rate, which of course looks like a whole bunch of yaw. It is fairly consistent, not a lot of ratcheting, and because I have such a rate on the airplane it couples a lot initially and it took a while for the nose to come down but still came down fairly quickly.

STEM 5 TEST 2
PILOT F
LONGITUDINAL CONFIGURATION 147
LATERAL CONFIGURATION 37

There's the roll followed by the bunt, there's the hang-up right there. There is a slight hesitation. From 40 alpha to 20 it moves pretty quickly and then stays at 20 for a little while. And then all of a sudden it breaks on through. You can see the nose and pitch down acceleration. It was difficult for me to control the angle of attack during the initial roll. I can control it. It's a little unusual for me to be trying to control alpha in a loaded roll like that. I'm just having a little trouble keeping it right at 38 or 40. It's kind of floating either down to 35 or going up to 45.

STEM 5 TEST 2
PILOT A
LONGITUDINAL CONFIGURATION 145
LATERAL CONFIGURATION 37

Pretty slow alpha drop off on that one. A moderate to high roll rate, but almost a linear drop off an alpha it looked like. It took a while to get the alpha back down. It didn't necessarily seem bad, but it's so hard to judge goodness or badness in here because I get no sensation of forces, and I'm not really clear on why I'm doing this, so it's hard to make a

qualitative judgement on it. The initial alpha really seemed to have a big effect on the time to recovery. I was basically in a rolling AOA hang up which took a cognizant amount of time to get the nose back down where I couldn't have done much else but wait. That seems to me to be much too slow in alpha response where basically I'm hung up and the airplane can't get my nose down for too long.

STEM 5 TEST 2
PILOT F
LONGITUDINAL CONFIGURATION 145
LATERAL CONFIGURATION 37

Here comes the bunt. Okay it's coming down fairly smoothly. That one the unload angle of attack rate was pretty much in line with the stick input. Yes, pretty good unload on that. Pretty much in line with stick. It has a lot of rolling moment to it, but the pitch breaks about the same rate as the stick input has made, which is good.

STEM 5 TEST 2
PILOT A
LONGITUDINAL CONFIGURATION 147
LATERAL CONFIGURATION 36

The way I'm doing this is to use full blower, go to about 80 degrees of bank, and pull it up to 38 alpha, and hold 38 alpha. As I hit 160 knots, I'm putting in a full aileron roll over and then I'm trying to play longitudinal stick. During the roll it couples up to 42 or 43 and then I immediately have to be bunting and then I get below 38. So when I put in my full lateral stick I'm trying to feed in just a hair of bunt so that I hold 38 all the way over. And then I can generally get the AOA stabilized somewhere around 38 when I do my unload through 180 degrees of roll. Of course I'm giving up an all speed control as soon as I start my roll over. But with this configuration I think I can do it consistently. In case you're wondering, that's how you depart a Hornet, a high g roll reversal, but that's probably not what we want to do here today. An immediate alpha break worked fine. Lots of pitch response. It looks like I can hold alpha about ±5 if I'm doing real well, ±10 if I get distracted. Lots of pitch response all the way to -14 alpha. That's about as clean a roll as I can get out of it. I held it about ±2 AOA on the way over and I had full lateral stick in. So that's all the rate it will give. Not a lot of roll ratcheting. The roll ratcheting is very sensitive to alpha of course, so they couple into each other and mess up the data.

STEM 5 TEST 2
PILOT F
LONGITUDINAL CONFIGURATION 147
LATERAL CONFIGURATION 36

That one seemed to be a little bit more sluggish in roll than the one before (lateral configuration 37). And then pitch unload seemed to be as quick if not quicker (than longitudinal 145). The roll in this thing is a little more sluggish. There seems to be a little bit of a roll hang-up, or it's just harder to get it to roll and then it comes over the top slower than the previous configuration. As you're going over to the 90 on the opposite side, you pick up a little roll acceleration. The unload is okay.

STEM 5 TEST 2
PILOT A
LONGITUDINAL CONFIGURATION 145
LATERAL CONFIGURATION 36

I don't really think you are going to get a lot of ratings out of the pilot on this because he is basically maxed out anyway. Unless the airplane departs or the response is so sluggish that nothing is happening. Or so responsive that I'd do an outside loop. It's all kind of lost in the violence of the maneuver, and all you are going to be able to get out of this is the open loop control response characteristics which is maybe what you want to see anyway.

STEM 5 TEST 2
PILOT F
LONGITUDINAL CONFIGURATION 145
LATERAL CONFIGURATION 36

The pitch seems very sensitive here and the roll is not all that good. It has a pretty brisk unload once it starts. The roll again is sluggish. Initial pitch unload doesn't do anything and then it takes off. There is about a second delay. When I'm starting to roll I'm getting a hang-up as soon as my wings get near wings level and then it's going on over to the 90 opposite position and then I do the pitch unload. So it looks like we got a roll hang-up somewhere around wings level and it doesn't seem to be affected by angle of attack. It's like it comes to wings level, hesitates there, and then keeps on going. I could see differences in the pitch sensitivity and the loaded roll. When you are rolling and trying to keep a constant AOA, you can tell differences in pitch sensitivity.

**Data Contents for STEM 6: Maximum Pitch Pull**

TEST 1: Maneuver tested at Vmin with AOA command systems
- Summary of Design Parameter Variations Tested

The following information is repeated for Analyses A, B, C, D, and E
- Numerical Summary of Statistical Analysis
- Bar Graphs of Measures of Merit
- Design Parameter Correlations, Pilot Variability, and Overall Correlations

The following information is located after Analyses A, B, C, D, and E
- Pilot Comments

Several statistical analyses are included to examine different ranges of CAP and AOAMAX as well as to compare the results from fractional factorial test matrices against full factorial matrices. If only one analysis is of interest, Analysis D should be used. The following is a list of the analyses included for STEM 6 TEST 1:

A Fractional factorial of CAP, ZSP, and AOAMAX (for AOAMAX 40° and 70°, and $\omega_{sp}$ 0.729 and 1.067).
B Fractional factorial of CAP, ZSP, and AOAMAX (for AOAMAX 40° and 55°, and $\omega_{sp}$ 0.729 and 1.067).
C Fractional factorial of CAP, ZSP, and AOAMAX (for AOAMAX 40° and 70°, and $\omega_{sp}$ 0.551 and 1.067).
D Full factorial (analyses A and E)
E Opposite half-fractional factorial of analysis A.

TEST 2: Maneuver tested at Vmin with pitch rate command systems
- Summary of Design Parameter Variations Tested
- Numerical Summary of Statistical Analysis
- Bar Graphs of Measures of Merit
- Design Parameter Correlations, Pilot Variability, and Overall Correlations
- Pilot Comments

TEST 3: Maneuver tested at Vc with AOA/Nz command systems
- Summary of Design Parameter Variations Tested
- Numerical Summary of Statistical Analysis
- Bar Graphs of Measures of Merit
- Design Parameter Correlations, Pilot Variability, and Overall Correlations
- Pilot Comments

## Summary of Design Parameters Tested for STEM 6 TEST 1

Test variables:

CAP: Indicates a variation in $\omega_{sp}$ since this is a low speed flight condition. $\omega_{sp}$ scheduled linearly with knots equivalent airspeed (KEAS) with the following value at 100 KEAS:

- (--) 0.551 rad/sec, Level 2 for high AOA acquisition from MCAIR research
- (-) 0.729 rad/sec, Level 1/2 boundary for high AOA acquisition from MCAIR research
- (+) 1.067 rad/sec, Solid Level 1 value for high AOA acquisition from MCAIR research

ZSP: A schedule of ZSP was implemented based on AOA:

For low AOA (≤10°), ZSP maintained at:

- (-) 0.35, Level 1/2 boundary from MIL-STD-1797A
- (+) 0.70, Level 1 from MIL-STD-1797A and generally good for acquisition

For high AOA (30°), ZSP maintained at:

- (-) 0.6, Level 1/2 boundary for high AOA maneuvering from MCAIR research
- (+) 1.2, Solid Level 1 value for high AOA maneuvering from MCAIR research

AOAMAX: Indicates a maximum AOA or load factor depending on flight condition. This also indicates a variation in stick sensitivity:

For low speed (<Vc), maximum AOA set at:

- (-) 40°, Aircraft can reach maximum lift but cannot reach post-stall
- (+) 55°, Aircraft can be flown post-stall
- (++) 70°, Aircraft can be flown post-stall

For high speed (≥Vc), maximum load factor set at:

- (-) 7g
- (+) 8g
- (++) 9g

### Configurations Tested (Pilots A,E)

| Lon Config | Lat Config | CAP ($\omega_{sp}$) | ZSP | AOAMAX |
|---|---|---|---|---|
| 100 | 2 | 0.729 (-) | 0.35/0.6 (-) | 9g/70° (++) |
| 101 | 2 | 1.067 (+) | 0.35/0.6 (-) | 7g/40° (-) |
| 102 | 2 | 0.729 (-) | 0.70/1.2 (+) | 7g/40° (-) |
| 103 | 2 | 1.067 (+) | 0.70/1.2 (+) | 9g/70° (++) |
| 115 | 2 | 0.729 (-) | 0.35/0.6 (-) | 8g/55° (+) |
| 116 | 2 | 1.067 (+) | 0.70/1.2 (+) | 8g/55° (+) |
| 117 | 2 | 0.551 (--) | 0.35/0.6 (-) | 9g/70° (++) |
| 118 | 2 | 0.551 (--) | 0.70/1.2 (+) | 7g/40° (-) |
| 150 | 2 | 0.729 (-) | 0.35/0.6 (-) | 7g/40° (-) |
| 151 | 2 | 1.067 (+) | 0.7/1.2 (+) | 7g/40° (-) |
| 152 | 2 | 0.729 (-) | 0.7/1.2 (+) | 9g/70° (++) |
| 153 | 2 | 1.067 (+) | 0.35/0.6 (-) | 9g/70° (++) |

## Summary of Design Parameters Tested for STEM 6 TEST 1

### Test Matrix for Analysis A (Pilots A,E)

| Lon Config | Lat Config | CAP (ωsp) | ZSP | AOAMAX |
|---|---|---|---|---|
| 100 | 2 | 0.729 (-) | 0.35/0.6 (-) | 9g/70° (++) |
| 101 | 2 | 1.067 (+) | 0.35/0.6 (-) | 7g/40° (-) |
| 102 | 2 | 0.729 (-) | 0.70/1.2 (+) | 7g/40° (-) |
| 103 | 2 | 1.067 (+) | 0.70/1.2 (+) | 9g/70° (++) |

### Test Matrix for Analysis B (Pilots A,E)

| Lon Config | Lat Config | CAP (ωsp) | ZSP | AOAMAX |
|---|---|---|---|---|
| 115 | 2 | 0.729 (-) | 0.35/0.6 (-) | 8g/55° (+) |
| 101 | 2 | 1.067 (+) | 0.35/0.6 (-) | 7g/40° (-) |
| 102 | 2 | 0.729 (-) | 0.70/1.2 (+) | 7g/40° (-) |
| 116 | 2 | 1.067 (+) | 0.70/1.2 (+) | 8g/55° (+) |

### Test Matrix for Analysis C (Pilots A,E)

| Lon Config | Lat Config | CAP (ωsp) | ZSP | AOAMAX |
|---|---|---|---|---|
| 117 | 2 | 0.551 (--) | 0.35/0.6 (-) | 9g/70° (++) |
| 101 | 2 | 1.067 (+) | 0.35/0.6 (-) | 7g/40° (-) |
| 118 | 2 | 0.551 (--) | 0.70/1.2 (+) | 7g/40° (-) |
| 103 | 2 | 1.067 (+) | 0.70/1.2 (+) | 9g/70° (++) |

### Test Matrix for Analysis D (Full Factorial, Pilots A,E)

| Lon Config | Lat Config | CAP (ωsp) | ZSP | AOAMAX |
|---|---|---|---|---|
| 100 | 2 | 0.729 (-) | 0.35/0.6 (-) | 9g/70° (++) |
| 101 | 2 | 1.067 (+) | 0.35/0.6 (-) | 7g/40° (-) |
| 102 | 2 | 0.729 (-) | 0.70/1.2 (+) | 7g/40° (-) |
| 103 | 2 | 1.067 (+) | 0.70/1.2 (+) | 9g/70° (++) |
| 150 | 2 | 0.729 (-) | 0.35/0.6 (-) | 7g/40° (-) |
| 151 | 2 | 1.067 (+) | 0.7/1.2 (+) | 7g/40° (-) |
| 152 | 2 | 0.729 (-) | 0.7/1.2 (+) | 9g/70° (++) |
| 153 | 2 | 1.067 (+) | 0.35/0.6 (-) | 9g/70° (++) |

### Test Matrix for Analysis E (Pilots A,E)

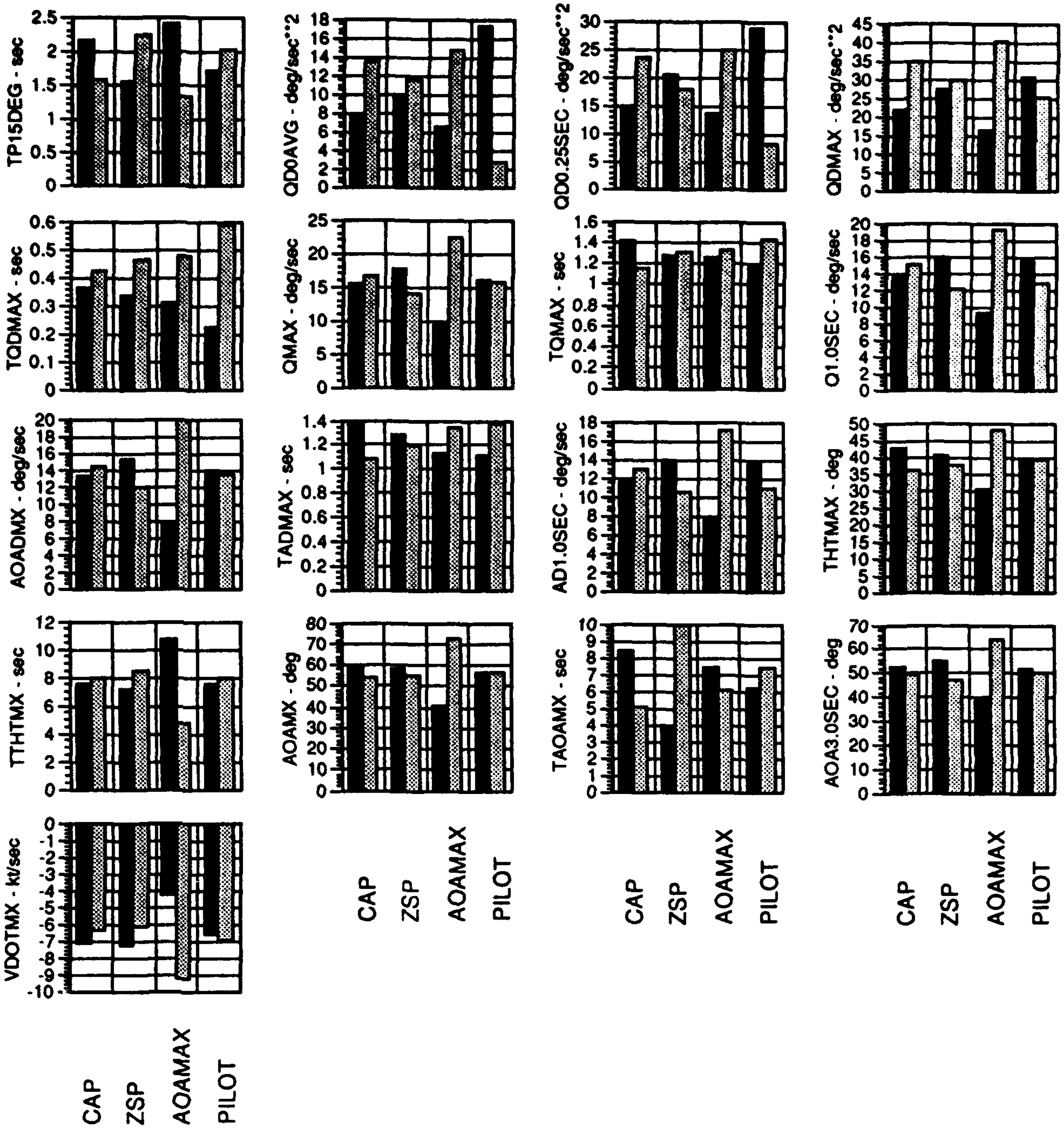
| Lon Config | Lat Config | CAP (ωsp) | ZSP | AOAMAX |
|---|---|---|---|---|
| 150 | 2 | 0.729 (-) | 0.35/0.6 (-) | 7g/40° (-) |
| 151 | 2 | 1.067 (+) | 0.7/1.2 (+) | 7g/40° (-) |
| 152 | 2 | 0.729 (-) | 0.70/1.2 (+) | 9g/70° (++) |
| 153 | 2 | 1.067 (+) | 0.35/0.6 (-) | 9g/70° (++) |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | TPXDEG | 0.9999 | CAP | 1.000 | 2.1461 | 1.5673 | 0 | 0 | -0.320 | 2.02 | 2 | 1 | 2 |
| | (15 deg) | | ZSP | 1.000 | 1.5334 | 2.2339 | 0 | 0 | 0.385 | 2.44 | 2 | 1 | 2 |
| | | | AOAMAX | 1.000 | 2.3943 | 1.3192 | 0 | 0 | -0.632 | 4.00 | 1 | 1 | 1 |
| | | | PLT | 1.000 | 1.7213 | 2.0147 | 0 | 0 | 0.158 | | | | |
| 4 | QD0AVG | 0.9999 | CAP | 1.000 | 7.7292 | 13.461 | 0 | 0 | 0.584 | 0.18 | 1 | 3 | 3 |
| | (0.25 sec) | | ZSP | 0.981 | 9.8581 | 11.455 | 0 | 0 | 0.151 | 0.05 | 3 | 3 | 4 |
| | | | AOAMAX | 1.000 | 6.4568 | 14.733 | 0 | 0 | 0.922 | 0.29 | 1 | 3 | 3 |
| | | | PLT | 1.000 | 17.408 | 2.0463 | 0 | 0 | -3.213 | | | | |
| 5 | QDXSEC | 0.9999 | CAP | 1.000 | 14.984 | 23.565 | 0 | 0 | 0.468 | 0.29 | 1 | 3 | 3 |
| | (0.25 sec) | | ZSP | 0.931 | 20.421 | 17.936 | 0 | 0 | -0.130 | 0.08 | 3 | 3 | 4 |
| | | | AOAMAX | 1.000 | 13.565 | 24.983 | 0 | 0 | 0.649 | 0.40 | 1 | 3 | 3 |
| | | | PLT | 1.000 | 28.815 | 8.1441 | 0 | 0 | -1.626 | | | | |
| 6 | QDMAX | 0.9999 | CAP | 1.000 | 21.789 | 34.836 | 0 | 0 | 0.487 | 2.36 | 1 | 1 | 1 |
| | | | ZSP | 0.980 | 27.073 | 29.759 | 0 | 0 | 0.095 | 0.46 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 16.562 | 40.064 | 0 | 0 | 1.003 | 4.86 | 1 | 1 | 1 |
| | | | PLT | 1.000 | 30.958 | 25.226 | 0 | 0 | -0.206 | | | | |
| 7 | TQDMAX | 0.9999 | CAP | 0.847 | 0.3652 | 0.4252 | 0 | 0 | 0.153 | 0.14 | 4 | 3 | 4 |
| | | | ZSP | 0.994 | 0.3373 | 0.4627 | 0 | 0 | 0.321 | 0.29 | 2 | 3 | 4 |
| | | | AOAMAX | 1.000 | 0.3108 | 0.4795 | 0 | 0 | 0.447 | 0.40 | 1 | 3 | 3 |
| | | | PLT | 1.000 | 0.2274 | 0.591 | 0 | 0 | 1.107 | | | | |
| 8 | QMAX | 0.9999 | CAP | 1.000 | 15.376 | 16.487 | 0 | 0 | 0.070 | 5.00 | 4 | 1 | 4 |
| | | | ZSP | 1.000 | 17.595 | 13.991 | 0 | 0 | -0.231 | 16.55 | 2 | 1 | 2 |
| | | | AOAMAX | 1.000 | 9.4324 | 22.43 | 0 | 0 | 0.979 | 70.04 | 1 | 1 | 1 |
| | | | PLT | 0.159 | 16.034 | 15.812 | 0 | 0 | -0.014 | | | | |
| 9 | TQMAX | 0.9999 | CAP | 1.000 | 1.4212 | 1.1527 | 0 | 0 | -0.211 | 1.00 | 2 | 3 | 4 |
| | | | ZSP | 0.671 | 1.2719 | 1.3045 | 0 | 0 | 0.025 | 0.12 | 4 | 3 | 4 |
| | | | AOAMAX | 0.852 | 1.2522 | 1.3218 | 0 | 0 | 0.054 | 0.26 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 1.162 | 1.4328 | 0 | 0 | 0.211 | | | | |
| 10 | QXSEC | 0.9999 | CAP | 0.945 | 13.551 | 14.928 | 0 | 0 | 0.097 | 0.51 | 4 | 3 | 4 |
| | (1.0 sec) | | ZSP | 1.000 | 15.994 | 12.192 | 0 | 0 | -0.275 | 1.46 | 2 | 2 | 3 |
| | | | AOAMAX | 1.000 | 9.2065 | 19.272 | 0 | 0 | 0.808 | 4.28 | 1 | 1 | 1 |
| | | | PLT | 0.998 | 15.46 | 12.815 | 0 | 0 | -0.189 | | | | |
| 11 | AOADMX | 0.9999 | CAP | 1.000 | 13.164 | 14.359 | 0 | 0 | 0.087 | 2.57 | 4 | 1 | 4 |
| | | | ZSP | 1.000 | 15.3 | 11.966 | 0 | 0 | -0.248 | 7.33 | 2 | 1 | 2 |
| | | | AOAMAX | 1.000 | 7.6056 | 19.917 | 0 | 0 | 1.118 | 33.01 | 1 | 1 | 1 |
| | | | PLT | 0.897 | 13.976 | 13.511 | 0 | 0 | -0.034 | | | | |
| 12 | TADMAX | 0.9999 | CAP | 1.000 | 1.39 | 1.0875 | 0 | 0 | -0.248 | 1.13 | 2 | 2 | 3 |
| | | | ZSP | 0.991 | 1.284 | 1.1859 | 0 | 0 | -0.080 | 0.36 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 1.1348 | 1.3426 | 0 | 0 | 0.169 | 0.77 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 1.1136 | 1.3848 | 0 | 0 | 0.220 | | | | |
| 13 | ADXSEC | 0.9999 | CAP | 0.935 | 11.688 | 12.98 | 0 | 0 | 0.105 | 0.52 | 3 | 3 | 4 |
| | (1.0 sec) | | ZSP | 1.000 | 13.969 | 10.426 | 0 | 0 | -0.297 | 1.48 | 2 | 2 | 3 |
| | | | AOAMAX | 1.000 | 7.5222 | 17.146 | 0 | 0 | 0.920 | 4.59 | 1 | 1 | 1 |
| | | | PLT | 0.996 | 13.456 | 11.025 | 0 | 0 | -0.201 | | | | |
| 18 | THTMAX | 0.9999 | CAP | 1.000 | 42.361 | 35.683 | 0 | 0 | -0.172 | 172.93 | 3 | 1 | 3 |
| | | | ZSP | 1.000 | 40.235 | 37.606 | 0 | 0 | -0.068 | 67.82 | 4 | 1 | 4 |
| | | | AOAMAX | 1.000 | 30.081 | 47.963 | 0 | 0 | 0.484 | 485.14 | 1 | 1 | 1 |
| | | | PLT | 0.333 | 39.04 | 39.001 | 0 | 0 | -0.001 | | | | |
| 19 | TTHTMX | 0.9999 | CAP | 0.984 | 7.5725 | 7.9324 | 0 | 0 | 0.046 | 0.88 | 4 | 3 | 4 |
| | | | ZSP | 1.000 | 7.1605 | 8.4429 | 0 | 0 | 0.165 | 3.15 | 3 | 1 | 3 |
| | | | AOAMAX | 1.000 | 10.736 | 4.769 | 0 | 0 | -0.903 | 17.17 | 1 | 1 | 1 |
| | | | PLT | 0.969 | 7.5639 | 7.9723 | 0 | 0 | 0.053 | | | | |
| 20 | AOAMX | 0.9999 | CAP | 1.000 | 59.034 | 54.119 | 0 | 0 | -0.087 | 152.44 | 4 | 1 | 4 |
| | | | ZSP | 1.000 | 58.497 | 54.336 | 0 | 0 | -0.074 | 129.37 | 4 | 1 | 4 |
| | | | AOAMAX | 1.000 | 40.736 | 72.417 | 0 | 0 | 0.608 | ###### | 1 | 1 | 1 |
| | | | PLT | 1.000 | 56.591 | 56.559 | 0 | 0 | -0.001 | | | | |

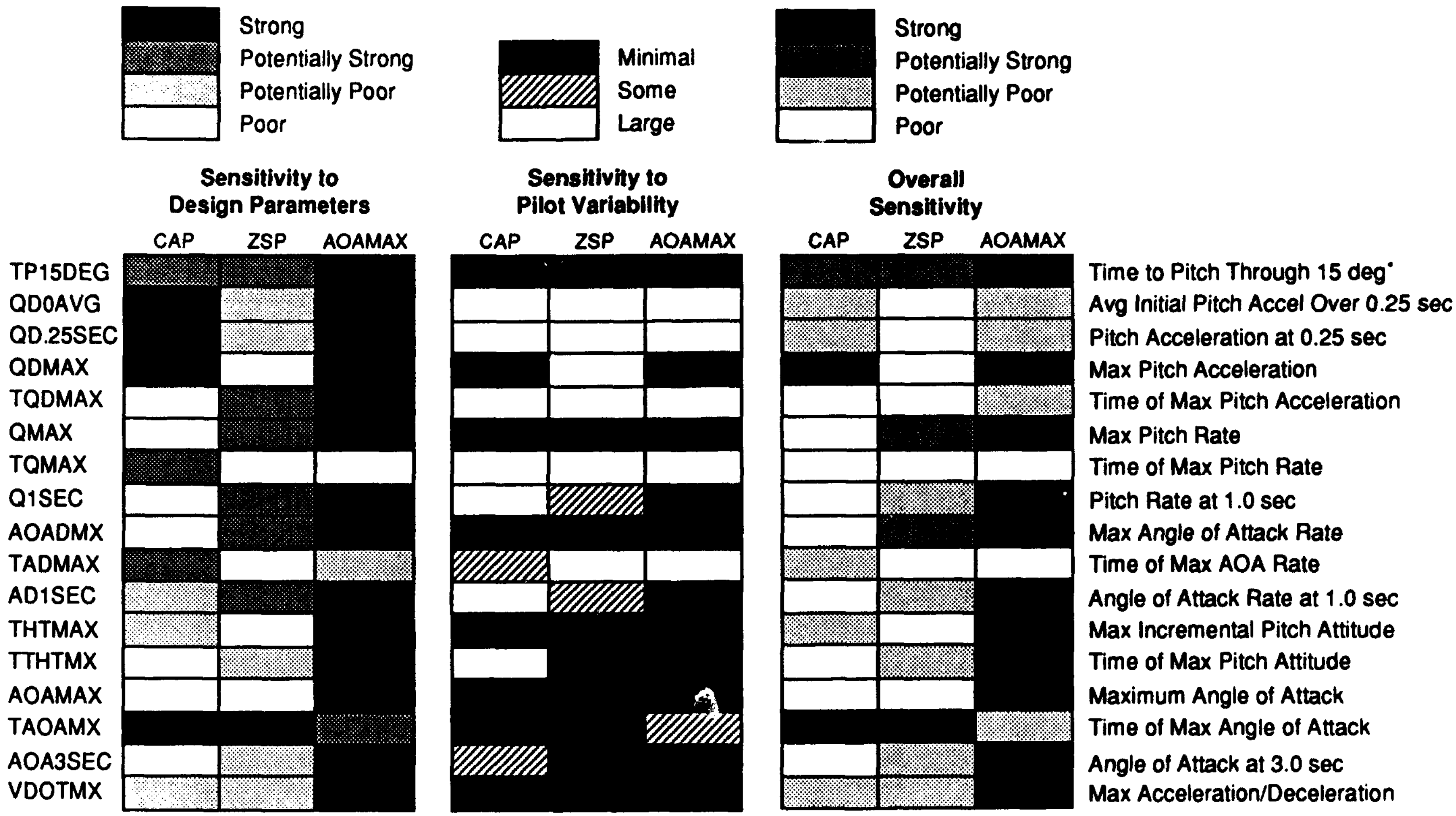
STEM 6 TEST 1 ANALYSIS A

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | TAOAMX | 0.9999 | CAP | 1.000 | 8.3704 | 5.1058 | 0 | 0 | -0.515 | 2.90 | 1 | 1 | 1 |
| | | | ZSP | 1.000 | 3.9959 | 9.9373 | 0 | 0 | 1.042 | 5.87 | 1 | 1 | 1 |
| | | | AOAMAX | 1.000 | 7.4217 | 6.0545 | 0 | 0 | -0.205 | 1.15 | 2 | 2 | 3 |
| | | | PLT | 0.949 | 6.1862 | 7.3819 | 0 | 0 | 0.178 | | | | |
| 22 | AOAXSEC | 0.9999 | CAP | 1.000 | 52.602 | 49.864 | 0 | 0 | -0.053 | 1.37 | 4 | 2 | 4 |
| | (3.0 sec) | | ZSP | 1.000 | 54.637 | 47.262 | 0 | 0 | -0.146 | 3.72 | 3 | 1 | 3 |
| | | | AOAMAX | 1.000 | 38.443 | 64.023 | 0 | 0 | 0.532 | 13.60 | 1 | 1 | 1 |
| | | | PLT | 1.000 | 52.157 | 50.155 | 0 | 0 | -0.039 | | | | |
| 38 | VDOTMX | 0.9999 | CAP | 1.000 | -7.2073 | -6.3229 | 0 | 0 | 0.131 | 3.02 | 3 | 1 | 3 |
| | | | ZSP | 1.000 | -7.3032 | -6.1373 | 0 | 0 | 0.175 | 4.02 | 3 | 1 | 3 |
| | | | AOAMAX | 1.000 | -4.2465 | -9.2837 | 0 | 0 | -0.864 | 19.87 | 1 | 1 | 1 |
| | | | PLT | 0.999 | -6.6291 | -6.9237 | 0 | 0 | -0.044 | | | | |

STEM 6 TEST 1 ANALYSIS A



STEM 6 TEST 1 ANALYSIS A

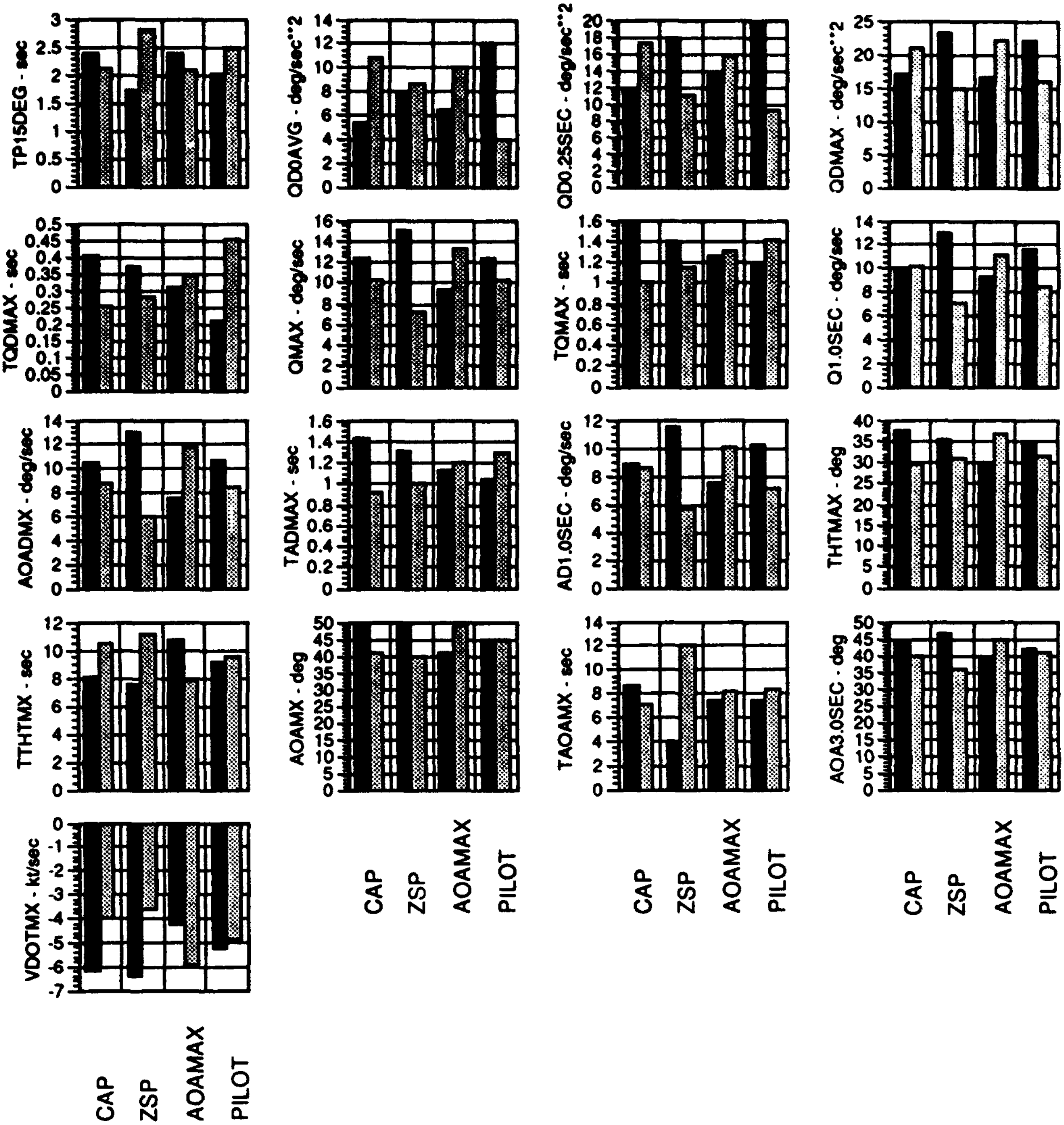


| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | TPXDEG | 0.9999 | CAP | 1.000 | 2.3965 | 2.1081 | 0 | 0 | -0.129 | 0.62 | 3 | 3 | 4 |
| | (15 deg) | | ZSP | 1.000 | 1.7174 | 2.8198 | 0 | 0 | 0.516 | 2.49 | 1 | 1 | 1 |
| | | | AOAMAX | 1.000 | 2.3943 | 2.0865 | 0 | 0 | -0.138 | 0.66 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 2.024 | 2.4876 | 0 | 0 | 0.208 | | | | |
| 4 | QD0AVG | 0.9999 | CAP | 1.000 | 5.3564 | 10.843 | 0 | 0 | 0.765 | 0.56 | 1 | 3 | 3 |
| | (0.25 sec) | | ZSP | 0.804 | 7.8316 | 8.6193 | 0 | 0 | 0.096 | 0.07 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 6.4568 | 10.109 | 0 | 0 | 0.463 | 0.34 | 1 | 3 | 3 |
| | | | PLT | 1.000 | 12.132 | 3.9605 | 0 | 0 | -1.368 | | | | |
| 5 | QDXSEC | 0.9999 | CAP | 1.000 | 11.716 | 17.287 | 0 | 0 | 0.399 | 0.48 | 2 | 3 | 4 |
| | (0.25 sec) | | ZSP | 1.000 | 17.824 | 11.135 | 0 | 0 | -0.488 | 0.59 | 1 | 3 | 3 |
| | | | AOAMAX | 0.964 | 13.565 | 15.748 | 0 | 0 | 0.150 | 0.18 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 19.584 | 9.2274 | 0 | 0 | -0.826 | | | | |
| 6 | QDMAX | 0.9999 | CAP | 1.000 | 17.13 | 21.119 | 0 | 0 | 0.211 | 0.64 | 2 | 3 | 4 |
| | | | ZSP | 1.000 | 23.179 | 14.899 | 0 | 0 | -0.457 | 1.38 | 1 | 2 | 2 |
| | | | AOAMAX | 1.000 | 16.562 | 22.067 | 0 | 0 | 0.291 | 0.88 | 2 | 3 | 4 |
| | | | PLT | 1.000 | 22.158 | 16.005 | 0 | 0 | -0.331 | | | | |
| 7 | TQDMAX | 0.9999 | CAP | 1.000 | 0.401 | 0.2551 | 0 | 0 | -0.468 | 0.55 | 1 | 3 | 3 |
| | | | ZSP | 0.995 | 0.3682 | 0.2785 | 0 | 0 | -0.283 | 0.33 | 2 | 3 | 4 |
| | | | AOAMAX | 0.633 | 0.3108 | 0.3407 | 0 | 0 | 0.092 | 0.11 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 0.2092 | 0.4508 | 0 | 0 | 0.845 | | | | |
| 8 | QMAX | 0.9999 | CAP | 1.000 | 12.396 | 10.318 | 0 | 0 | -0.185 | 0.95 | 3 | 3 | 4 |
| | | | ZSP | 1.000 | 15.015 | 7.3074 | 0 | 0 | -0.784 | 4.02 | 1 | 1 | 1 |
| | | | AOAMAX | 1.000 | 9.4324 | 13.355 | 0 | 0 | 0.355 | 1.82 | 2 | 2 | 3 |
| | | | PLT | 1.000 | 12.361 | 10.183 | 0 | 0 | -0.195 | | | | |
| 9 | TQMAX | 0.9999 | CAP | 1.000 | 1.5794 | 1.0087 | 0 | 0 | -0.464 | 2.42 | 1 | 1 | 1 |
| | | | ZSP | 1.000 | 1.4064 | 1.1486 | 0 | 0 | -0.204 | 1.06 | 2 | 2 | 3 |
| | | | AOAMAX | 0.639 | 1.2522 | 1.3157 | 0 | 0 | 0.049 | 0.26 | 4 | 3 | 4 |
| | | | PLT | 0.999 | 1.1653 | 1.4097 | 0 | 0 | 0.192 | | | | |
| 10 | QXSEC | 0.9999 | CAP | 0.146 | 10.097 | 10.165 | 0 | 0 | 0.007 | 0.02 | 4 | 3 | 4 |
| | (1.0 sec) | | ZSP | 1.000 | 12.994 | 7.0317 | 0 | 0 | -0.653 | 2.04 | 1 | 1 | 1 |
| | | | AOAMAX | 1.000 | 9.2065 | 11.135 | 0 | 0 | 0.191 | 0.60 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 11.64 | 8.4991 | 0 | 0 | -0.320 | | | | |
| 11 | AOADMX | 0.9999 | CAP | 1.000 | 10.507 | 8.8098 | 0 | 0 | -0.177 | 0.75 | 3 | 3 | 4 |
| | | | ZSP | 1.000 | 13.012 | 5.9545 | 0 | 0 | -0.864 | 3.66 | 1 | 1 | 1 |
| | | | AOAMAX | 1.000 | 7.6056 | 11.811 | 0 | 0 | 0.455 | 1.93 | 1 | 2 | 2 |
| | | | PLT | 1.000 | 10.694 | 8.4648 | 0 | 0 | -0.236 | | | | |
| 12 | TADMAX | 0.9999 | CAP | 1.000 | 1.4294 | 0.926 | 0 | 0 | -0.448 | 2.10 | 1 | 1 | 1 |
| | | | ZSP | 1.000 | 1.3122 | 1.011 | 0 | 0 | -0.264 | 1.24 | 2 | 2 | 3 |
| | | | AOAMAX | 0.748 | 1.1348 | 1.2032 | 0 | 0 | 0.059 | 0.27 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 1.0489 | 1.2963 | 0 | 0 | 0.213 | | | | |
| 13 | ADXSEC | 0.9999 | CAP | 0.750 | 8.9426 | 8.5844 | 0 | 0 | -0.041 | 0.11 | 4 | 3 | 4 |
| | (1.0 sec) | | ZSP | 1.000 | 11.611 | 5.6642 | 0 | 0 | -0.781 | 2.19 | 1 | 1 | 1 |
| | | | AOAMAX | 1.000 | 7.5222 | 10.093 | 0 | 0 | 0.298 | 0.84 | 2 | 3 | 4 |
| | | | PLT | 1.000 | 10.198 | 7.1942 | 0 | 0 | -0.356 | | | | |
| 18 | THTMAX | 0.9999 | CAP | 1.000 | 37.5 | 29.407 | 0 | 0 | -0.246 | 2.43 | 2 | 1 | 2 |
| | | | ZSP | 1.000 | 35.585 | 30.808 | 0 | 0 | -0.145 | 1.43 | 3 | 2 | 4 |
| | | | AOAMAX | 1.000 | 30.081 | 36.77 | 0 | 0 | 0.202 | 2.00 | 2 | 1 | 2 |
| | | | PLT | 1.000 | 34.896 | 31.554 | 0 | 0 | -0.101 | | | | |
| 19 | TTHTMX | 0.9999 | CAP | 1.000 | 8.0883 | 10.488 | 0 | 0 | 0.263 | 8.14 | 2 | 1 | 2 |
| | | | ZSP | 1.000 | 7.605 | 11.212 | 0 | 0 | 0.398 | 12.32 | 2 | 1 | 2 |
| | | | AOAMAX | 1.000 | 10.736 | 7.8199 | 0 | 0 | -0.322 | 9.98 | 2 | 1 | 2 |
| | | | PLT | 0.996 | 9.1914 | 9.493 | 0 | 0 | 0.032 | | | | |
| 20 | AOAMX | 0.9999 | CAP | 1.000 | 49.399 | 40.804 | 0 | 0 | -0.192 | 95.80 | 3 | 1 | 3 |
| | | | ZSP | 1.000 | 49.562 | 39.911 | 0 | 0 | -0.218 | 108.72 | 2 | 1 | 2 |
| | | | AOAMAX | 1.000 | 40.736 | 49.472 | 0 | 0 | 0.196 | 97.39 | 3 | 1 | 3 |
| | | | PLT | 1.000 | 44.973 | 44.883 | 0 | 0 | -0.002 | | | | |

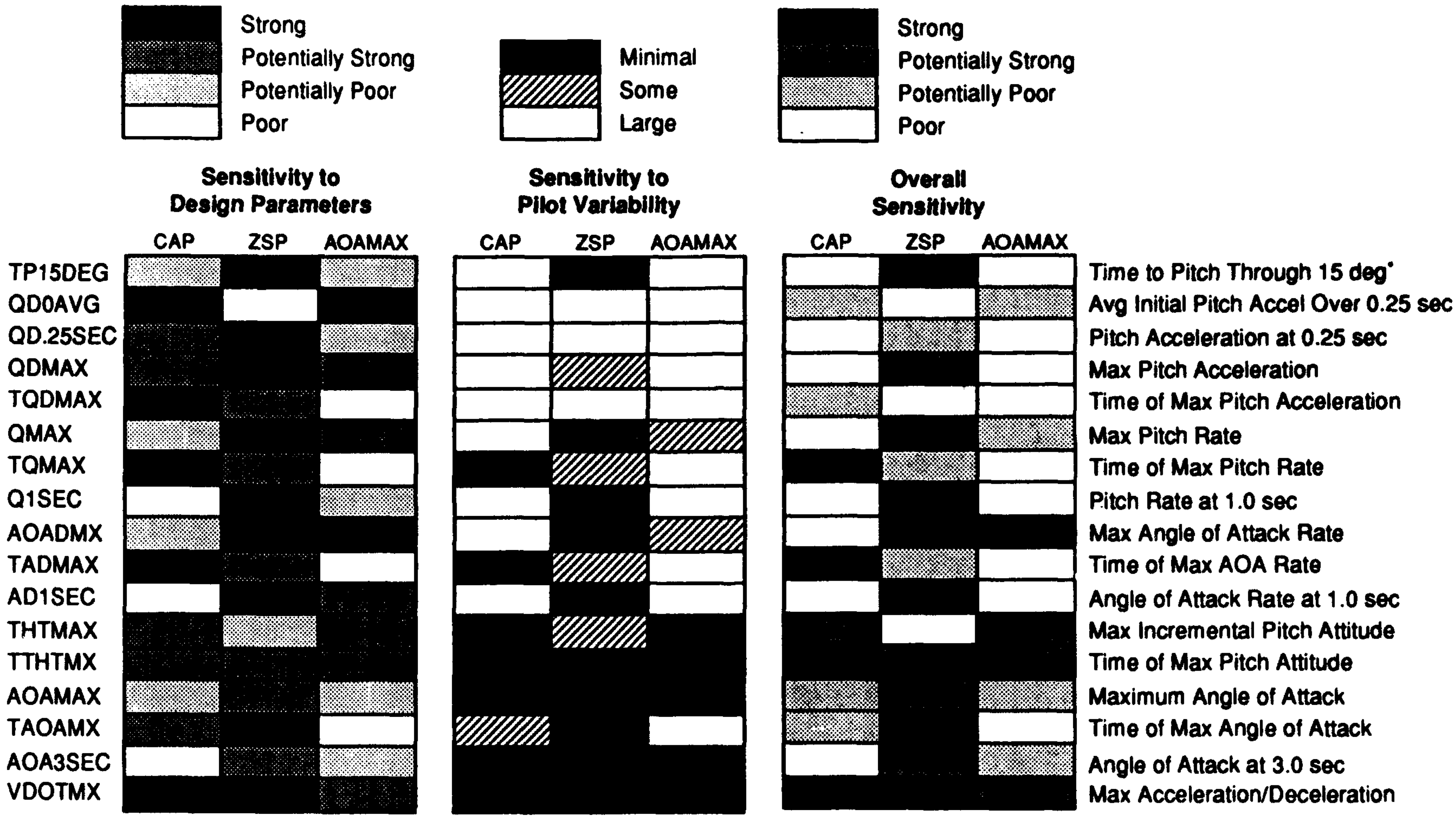
STEM 6 TEST 1 ANALYSIS B

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | TAOAMX | 0.9999 | CAP | 1.000 | 8.6422 | 7.0549 | 0 | 0 | -0.204 | 1.70 | 2 | 2 | 3 |
| | | | ZSP | 1.000 | 3.9103 | 12.049 | 0 | 0 | 1.378 | 11.45 | 1 | 1 | 1 |
| | | | AOAMAX | 0.839 | 7.4217 | 8.2449 | 0 | 0 | 0.105 | 0.88 | 4 | 3 | 4 |
| | | | PLT | 0.908 | 7.3657 | 8.3054 | 0 | 0 | 0.120 | | | | |
| 22 | AOAXSEC | 0.9999 | CAP | 1.000 | 43.633 | 39.543 | 0 | 0 | -0.099 | 3.31 | 4 | 1 | 4 |
| | (3.0 sec) | | ZSP | 1.000 | 46.515 | 36.081 | 0 | 0 | -0.257 | 8.62 | 2 | 1 | 2 |
| | | | AOAMAX | 1.000 | 38.443 | 44.825 | 0 | 0 | 0.154 | 5.18 | 3 | 1 | 3 |
| | | | PLT | 0.987 | 42.099 | 40.864 | 0 | 0 | -0.030 | | | | |
| 38 | VDOTMX | 0.9999 | CAP | 1.000 | -6.2047 | -3.9832 | 0 | 0 | 0.458 | 6.06 | 1 | 1 | 1 |
| | | | ZSP | 1.000 | -6.3851 | -3.6026 | 0 | 0 | 0.604 | 8.00 | 1 | 1 | 1 |
| | | | AOAMAX | 1.000 | -4.2465 | -5.9194 | 0 | 0 | -0.338 | 4.48 | 2 | 1 | 2 |
| | | | PLT | 0.907 | -5.232 | -4.8518 | 0 | 0 | 0.076 | | | | |

STEM 6 TEST 1 ANALYSIS B



STEM 6 TEST 1 ANALYSIS B

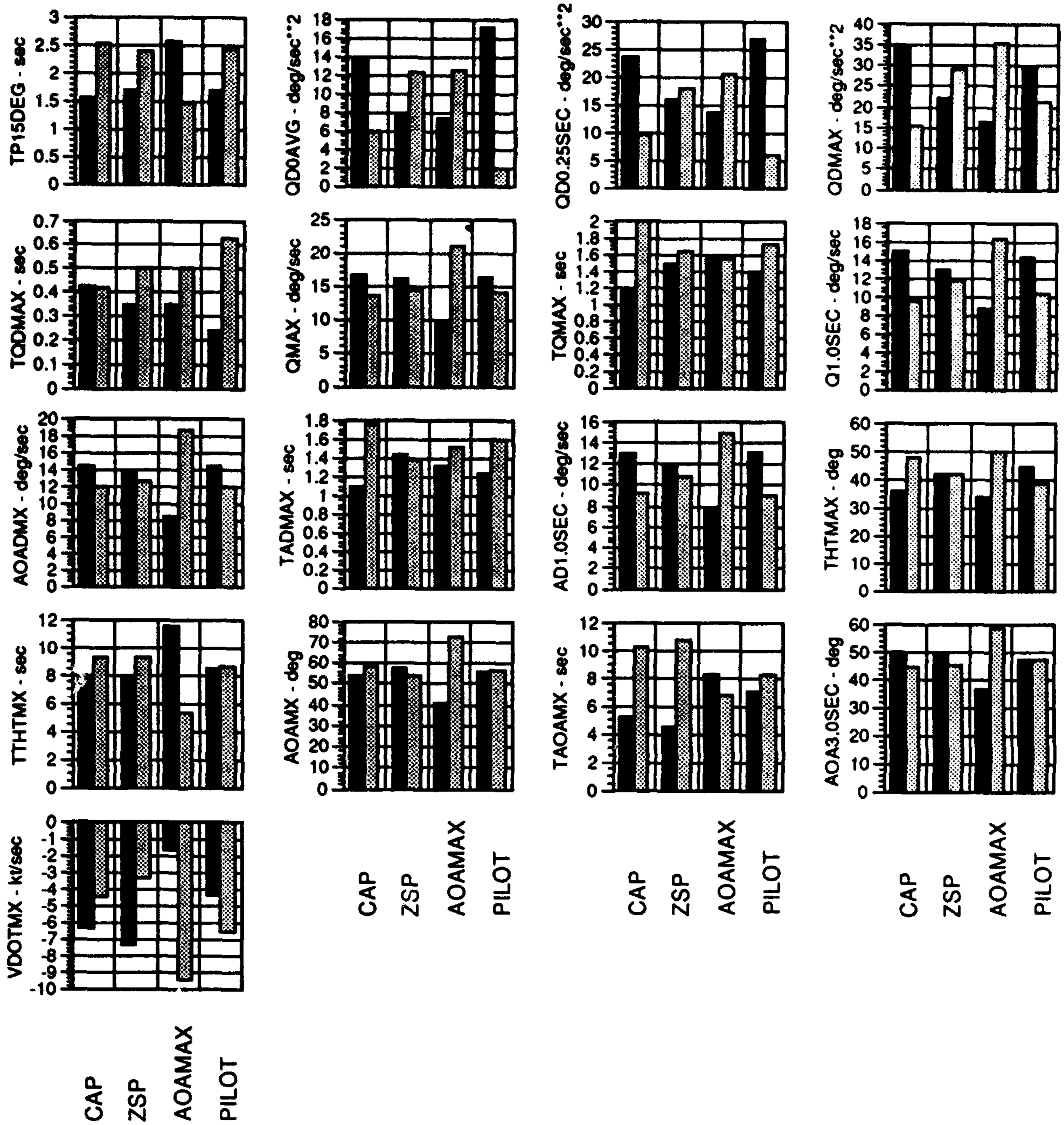


| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | TPXDEG | 0.9999 | CAP | 1.000 | 1.5673 | 2.5326 | 0 | 0 | 0.499 | 1.36 | 1 | 2 | 2 |
| | (15 deg) | | ZSP | 1.000 | 1.6882 | 2.4016 | 0 | 0 | 0.360 | 0.98 | 2 | 3 | 4 |
| | | | AOAMAX | 1.000 | 2.5491 | 1.469 | 0 | 0 | -0.580 | 1.58 | 1 | 2 | 2 |
| | | | PLT | 1.000 | 1.6816 | 2.4088 | 0 | 0 | 0.367 | | | | |
| 4 | QD0AVG | 0.9999 | CAP | 1.000 | 13.461 | 5.8633 | 0 | 0 | -0.930 | 0.21 | 1 | 3 | 3 |
| | (0.25 sec) | | ZSP | 1.000 | 7.4642 | 12.36 | 0 | 0 | 0.526 | 0.12 | 1 | 3 | 3 |
| | | | AOAMAX | 1.000 | 7.2921 | 12.546 | 0 | 0 | 0.570 | 0.13 | 1 | 3 | 3 |
| | | | PLT | 1.000 | 17.086 | 1.9362 | 0 | 0 | -4.356 | | | | |
| 5 | QDXSEC | 0.9999 | CAP | 1.000 | 23.565 | 9.6373 | 0 | 0 | -1.018 | 0.47 | 1 | 3 | 3 |
| | (0.25 sec) | | ZSP | 0.905 | 16.019 | 17.812 | 0 | 0 | 0.106 | 0.05 | 3 | 3 | 4 |
| | | | AOAMAX | 1.000 | 13.451 | 20.595 | 0 | 0 | 0.439 | 0.20 | 1 | 3 | 3 |
| | | | PLT | 1.000 | 27.008 | 5.907 | 0 | 0 | -2.177 | | | | |
| 6 | QDMAX | 0.9999 | CAP | 1.000 | 34.836 | 15.293 | 0 | 0 | -0.919 | 2.62 | 1 | 1 | 1 |
| | | | ZSP | 1.000 | 21.942 | 29.262 | 0 | 0 | 0.292 | 0.83 | 2 | 3 | 4 |
| | | | AOAMAX | 1.000 | 16.104 | 35.587 | 0 | 0 | 0.879 | 2.51 | 1 | 1 | 1 |
| | | | PLT | 1.000 | 29.587 | 20.98 | 0 | 0 | -0.351 | | | | |
| 7 | TQDMAX | 0.9999 | CAP | 0.071 | 0.4252 | 0.4201 | 0 | 0 | -0.012 | 0.01 | 4 | 3 | 4 |
| | | | ZSP | 0.988 | 0.3467 | 0.5051 | 0 | 0 | 0.385 | 0.34 | 2 | 3 | 4 |
| | | | AOAMAX | 0.980 | 0.3499 | 0.5016 | 0 | 0 | 0.368 | 0.32 | 2 | 3 | 4 |
| | | | PLT | 1.000 | 0.2347 | 0.6264 | 0 | 0 | 1.147 | | | | |
| 8 | QMAX | 0.9999 | CAP | 1.000 | 16.487 | 13.634 | 0 | 0 | -0.191 | 1.30 | 3 | 2 | 4 |
| | | | ZSP | 1.000 | 15.881 | 14.291 | 0 | 0 | -0.106 | 0.72 | 3 | 3 | 4 |
| | | | AOAMAX | 1.000 | 9.7096 | 20.976 | 0 | 0 | 0.849 | 5.77 | 1 | 1 | 1 |
| | | | PLT | 1.000 | 16.177 | 13.97 | 0 | 0 | -0.147 | | | | |
| 9 | TQMAX | 0.9999 | CAP | 1.000 | 1.1527 | 1.9867 | 0 | 0 | 0.572 | 2.52 | 1 | 1 | 1 |
| | | | ZSP | 0.996 | 1.4849 | 1.6268 | 0 | 0 | 0.091 | 0.40 | 4 | 3 | 4 |
| | | | AOAMAX | 0.617 | 1.5497 | 1.5567 | 0 | 0 | 0.005 | 0.02 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 1.3852 | 1.7349 | 0 | 0 | 0.227 | | | | |
| 10 | QXSEC | 0.9999 | CAP | 1.000 | 14.928 | 9.5993 | 0 | 0 | -0.456 | 1.36 | 1 | 2 | 2 |
| | (1.0 sec) | | ZSP | 0.859 | 12.981 | 11.709 | 0 | 0 | -0.103 | 0.31 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 8.7605 | 16.281 | 0 | 0 | 0.660 | 1.97 | 1 | 2 | 2 |
| | | | PLT | 1.000 | 14.296 | 10.284 | 0 | 0 | -0.335 | | | | |
| 11 | AOADMX | 0.9999 | CAP | 1.000 | 14.359 | 11.921 | 0 | 0 | -0.187 | 1.01 | 3 | 2 | 4 |
| | | | ZSP | 0.999 | 13.656 | 12.683 | 0 | 0 | -0.074 | 0.40 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 8.2674 | 18.52 | 0 | 0 | 0.897 | 4.82 | 1 | 1 | 1 |
| | | | PLT | 1.000 | 14.352 | 11.928 | 0 | 0 | -0.186 | | | | |
| 12 | TADMAX | 0.9999 | CAP | 1.000 | 1.0875 | 1.7576 | 0 | 0 | 0.499 | 1.90 | 1 | 2 | 2 |
| | | | ZSP | 0.921 | 1.4369 | 1.3791 | 0 | 0 | -0.041 | 0.16 | 4 | 3 | 4 |
| | | | AOAMAX | 0.999 | 1.3132 | 1.5131 | 0 | 0 | 0.142 | 0.54 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 1.2333 | 1.5996 | 0 | 0 | 0.263 | | | | |
| 13 | ADXSEC | 0.9999 | CAP | 1.000 | 12.98 | 9.2442 | 0 | 0 | -0.346 | 0.89 | 2 | 3 | 4 |
| | (1.0 sec) | | ZSP | 0.677 | 11.584 | 10.757 | 0 | 0 | -0.074 | 0.19 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 7.8276 | 14.826 | 0 | 0 | 0.683 | 1.77 | 1 | 2 | 2 |
| | | | PLT | 1.000 | 13.177 | 9.0306 | 0 | 0 | -0.387 | | | | |
| 18 | THTMAX | 0.9999 | CAP | 1.000 | 35.683 | 47.931 | 0 | 0 | 0.299 | 2.02 | 2 | 1 | 2 |
| | | | ZSP | 0.487 | 41.546 | 41.579 | 0 | 0 | 0.001 | 0.01 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 33.748 | 50.027 | 0 | 0 | 0.404 | 2.73 | 1 | 1 | 1 |
| | | | PLT | 1.000 | 44.487 | 38.393 | 0 | 0 | -0.148 | | | | |
| 19 | TTHTMX | 0.9999 | CAP | 1.000 | 7.9324 | 9.2451 | 0 | 0 | 0.154 | 5.73 | 3 | 1 | 3 |
| | | | ZSP | 1.000 | 7.8758 | 9.3064 | 0 | 0 | 0.168 | 6.25 | 3 | 1 | 3 |
| | | | AOAMAX | 1.000 | 11.533 | 5.3445 | 0 | 0 | -0.847 | 31.56 | 1 | 1 | 1 |
| | | | PLT | 0.967 | 8.4521 | 8.682 | 0 | 0 | 0.027 | | | | |
| 20 | AOAMX | 0.9999 | CAP | 1.000 | 54.119 | 58.128 | 0 | 0 | 0.072 | 3.39 | 4 | 1 | 4 |
| | | | ZSP | 1.000 | 57.644 | 54.309 | 0 | 0 | -0.060 | 2.83 | 4 | 1 | 4 |
| | | | AOAMAX | 1.000 | 40.712 | 72.653 | 0 | 0 | 0.612 | 29.00 | 1 | 1 | 1 |
| | | | PLT | 0.191 | 55.476 | 56.659 | 0 | 0 | 0.021 | | | | |

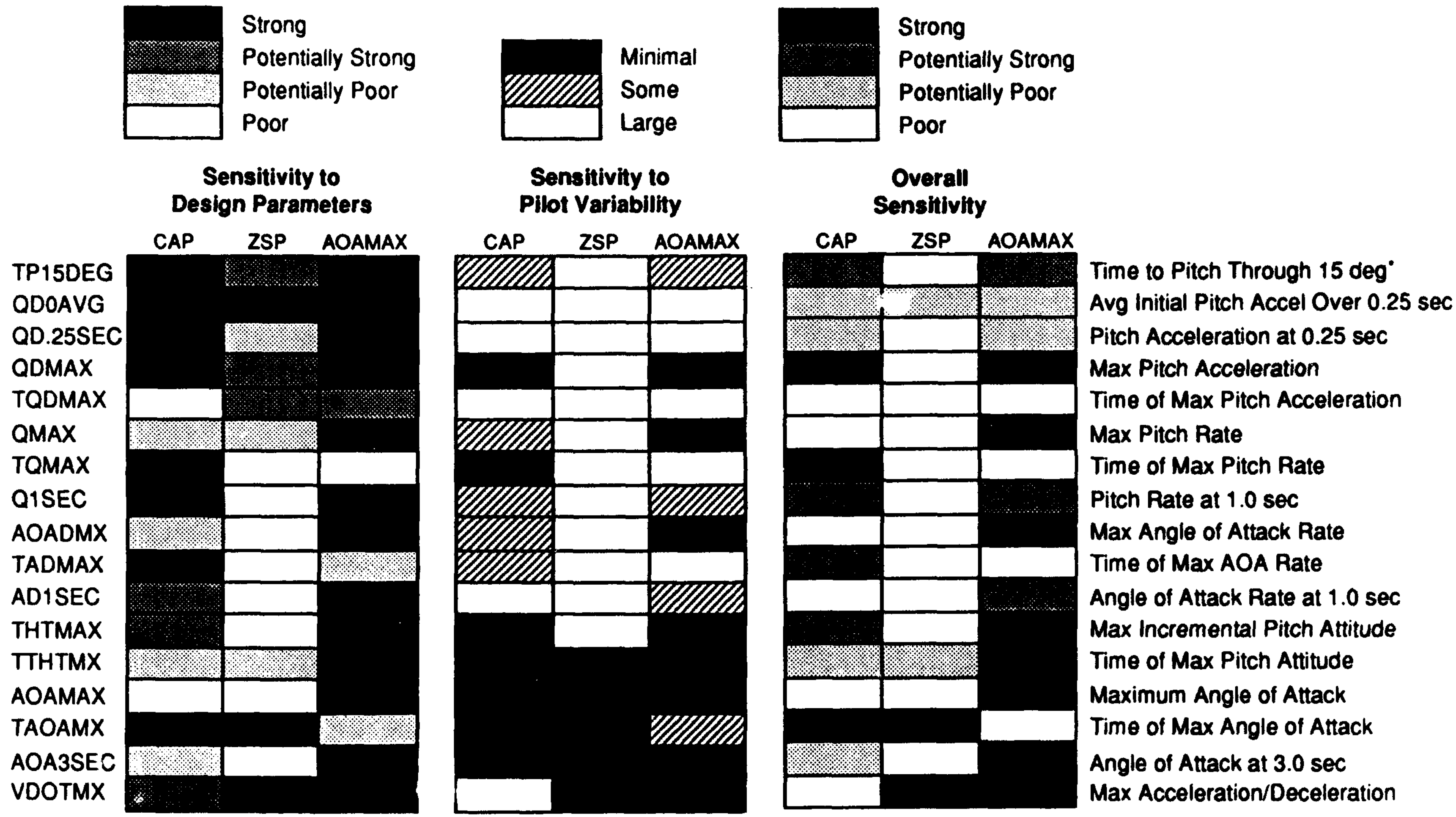
STEM 6 TEST 1 ANALYSIS C

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | TAOAMX | 0.9999 | CAP | 1.000 | 5.1058 | 10.187 | 0 | 0 | 0.747 | 4.54 | 1 | 1 | 1 |
| | | | ZSP | 1.000 | 4.5349 | 10.805 | 0 | 0 | 0.981 | 5.97 | 1 | 1 | 1 |
| | | | AOAMAX | 1.000 | 8.2228 | 6.81 | 0 | 0 | -0.190 | 1.15 | 3 | 2 | 4 |
| | | | PLT | 0.969 | 6.9508 | 8.1879 | 0 | 0 | 0.165 | | | | |
| 22 | AOAXSEC | 0.9999 | CAP | 1.000 | 49.864 | 44.267 | 0 | 0 | -0.119 | 19.41 | 3 | 1 | 3 |
| | (3.0 sec) | | ZSP | 1.000 | 49.014 | 45.188 | 0 | 0 | -0.081 | 13.23 | 4 | 1 | 4 |
| | | | AOAMAX | 1.000 | 36.529 | 58.714 | 0 | 0 | 0.493 | 80.12 | 1 | 1 | 1 |
| | | | PLT | 0.958 | 47.317 | 47.027 | 0 | 0 | -0.006 | | | | |
| 38 | VDOTMX | 0.9999 | CAP | 1.000 | -6.3229 | -4.5221 | 0 | 0 | 0.342 | 0.84 | 2 | 3 | 4 |
| | | | ZSP | 1.000 | -7.3663 | -3.3917 | 0 | 0 | 0.856 | 2.09 | 1 | 1 | 1 |
| | | | AOAMAX | 1.000 | -1.7122 | -9.5171 | 0 | 0 | -2.689 | 6.58 | 1 | 1 | 1 |
| | | | PLT | 1.000 | -4.4205 | -6.583 | 0 | 0 | -0.409 | | | | |

STEM 6 TEST 1 ANALYSIS C



STEM 6 TEST 1 ANALYSIS C

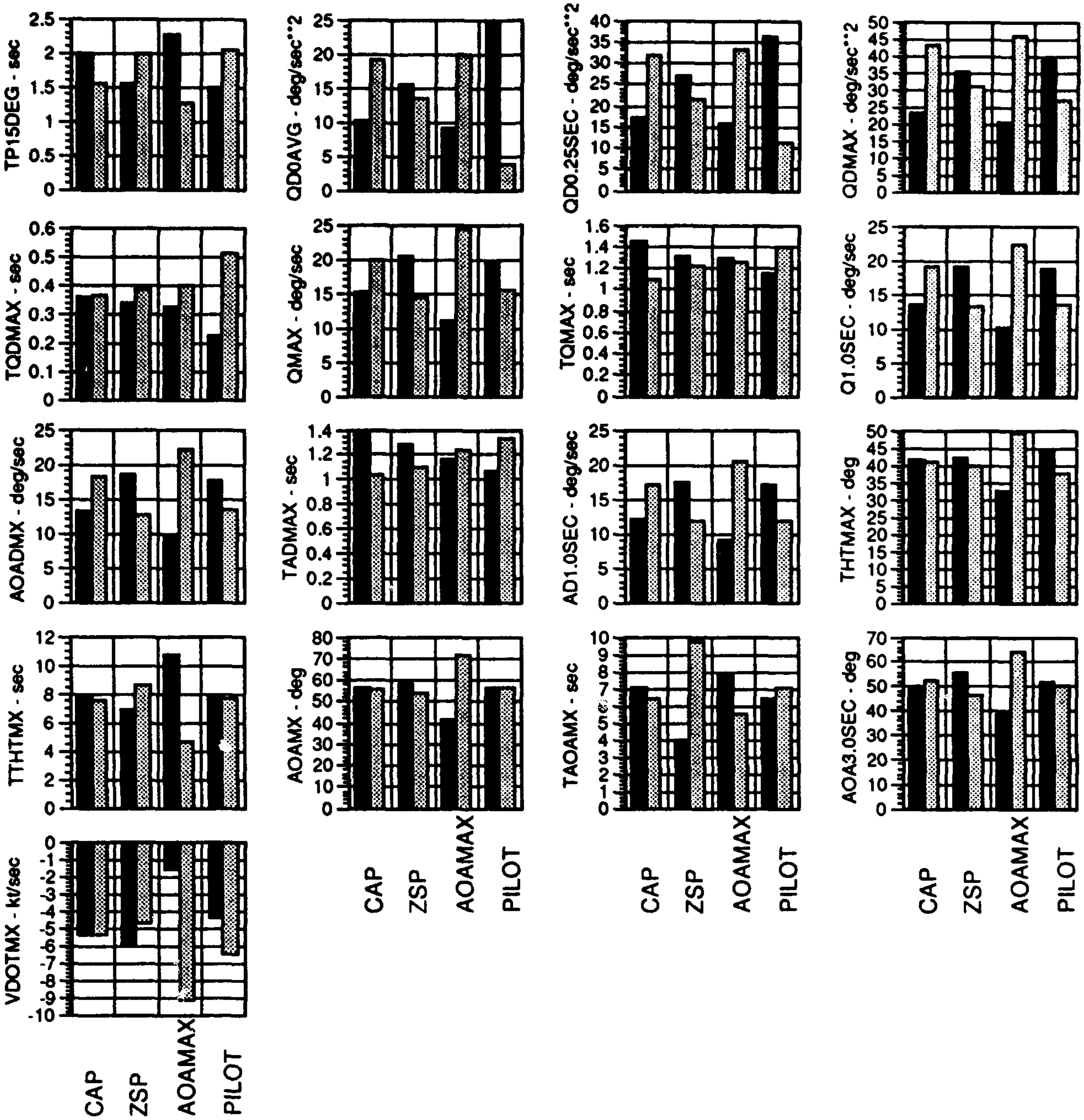


STEM 6 TEST 1 ANALYSIS D

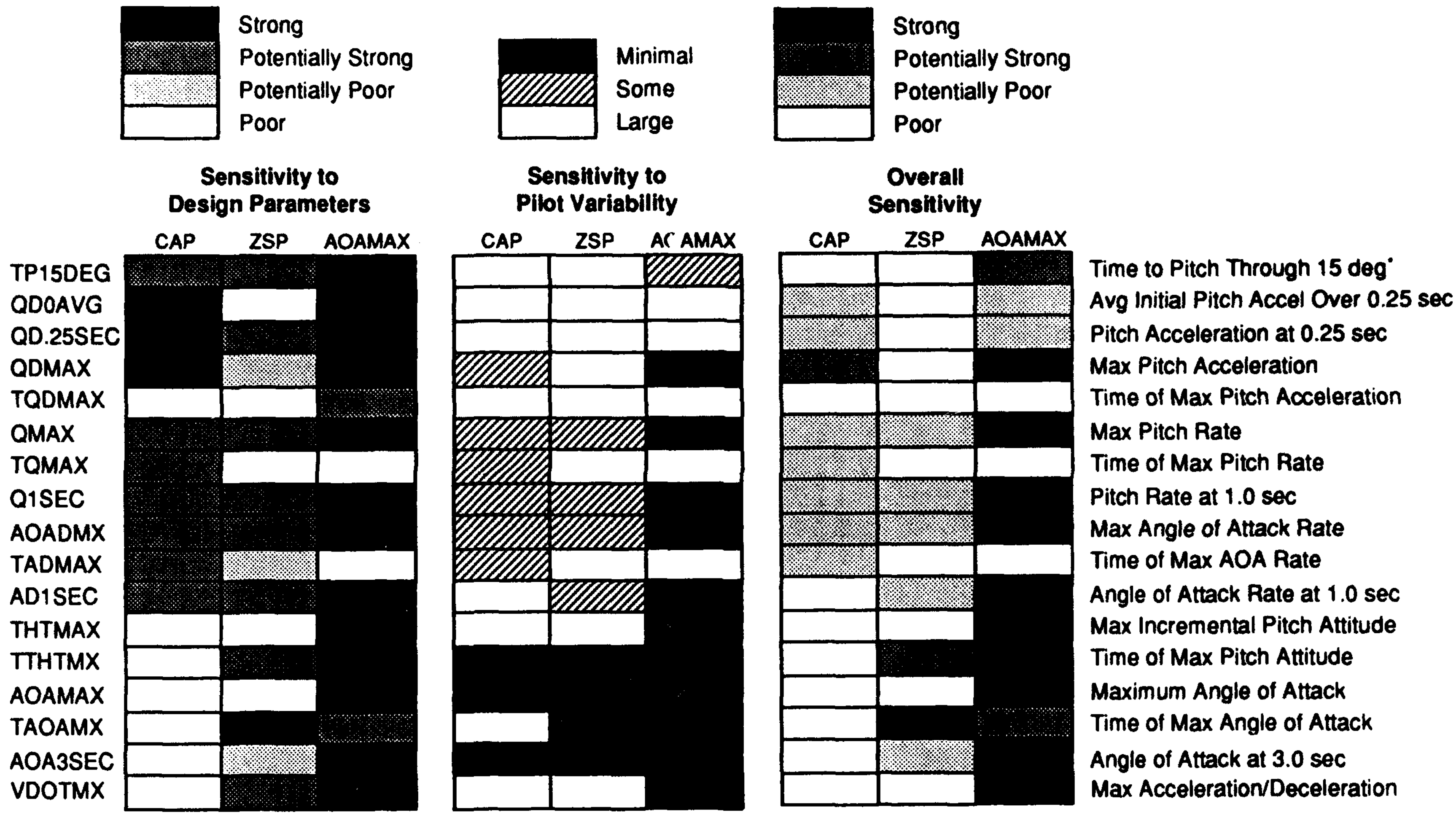
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | TPXDEG | 0.9999 | CAP | 1.000 | 1.9877 | 1.5451 | 0 | 0 | -0.255 | 0.79 | 2 | 3 | 4 |
| | (15 deg) | | ZSP | 1.000 | 1.5498 | 2.001 | 0 | 0 | 0.258 | 0.80 | 2 | 3 | 4 |
| | | | AOAMAX | 1.000 | 2.2765 | 1.2563 | 0 | 0 | -0.630 | 1.95 | 1 | 2 | 2 |
| | | | PLT | 1.000 | 1.4976 | 2.0576 | 0 | 0 | 0.323 | | | | |
| 4 | QD0AVG | 0.9999 | CAP | 1.000 | 10.107 | 19.023 | 0 | 0 | 0.675 | 0.21 | 1 | 3 | 3 |
| | (0.25 sec) | | ZSP | 0.825 | 15.58 | 13.466 | 0 | 0 | -0.146 | 0.05 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 9.1697 | 19.96 | 0 | 0 | 0.859 | 0.27 | 1 | 3 | 3 |
| | | | PLT | 1.000 | 24.504 | 3.7975 | 0 | 0 | -3.149 | | | | |
| 5 | QDXSEC | 0.9999 | CAP | 1.000 | 17.175 | 31.668 | 0 | 0 | 0.651 | 0.46 | 1 | 3 | 3 |
| | (0.25 sec) | | ZSP | 0.989 | 27.051 | 21.573 | 0 | 0 | -0.228 | 0.16 | 2 | 3 | 4 |
| | | | AOAMAX | 1.000 | 15.745 | 33.098 | 0 | 0 | 0.813 | 0.58 | 1 | 3 | 3 |
| | | | PLT | 1.000 | 36.259 | 11.597 | 0 | 0 | -1.403 | | | | |
| 6 | QDMAX | 0.9999 | CAP | 1.000 | 23.321 | 42.954 | 0 | 0 | 0.649 | 1.82 | 1 | 2 | 2 |
| | | | ZSP | 1.000 | 35.143 | 30.965 | 0 | 0 | -0.127 | 0.36 | 3 | 3 | 4 |
| | | | AOAMAX | 1.000 | 20.208 | 46.067 | 0 | 0 | 0.920 | 2.58 | 1 | 1 | 1 |
| | | | PLT | 1.000 | 38.597 | 27.223 | 0 | 0 | -0.356 | | | | |
| 7 | TQDMAX | 0.9999 | CAP | 0.278 | 0.3556 | 0.3652 | 0 | 0 | 0.027 | 0.03 | 4 | 3 | 4 |
| | | | ZSP | 0.872 | 0.3404 | 0.3821 | 0 | 0 | 0.116 | 0.12 | 4 | 3 | 4 |
| | | | AOAMAX | 0.992 | 0.3231 | 0.3976 | 0 | 0 | 0.209 | 0.22 | 2 | 3 | 4 |
| | | | PLT | 1.000 | 0.222 | 0.5103 | 0 | 0 | 0.932 | | | | |
| 8 | QMAX | 0 | CAP | 1.000 | 15.16 | 19.982 | 0 | 0 | 0.280 | 1.21 | 2 | 2 | 3 |
| | | | ZSP | 1.000 | 20.549 | 14.345 | 0 | 0 | -0.367 | 1.58 | 2 | 2 | 3 |
| | | | AOAMAX | 1.000 | 10.879 | 24.263 | 0 | 0 | 0.891 | 3.84 | 1 | 1 | 1 |
| | | | PLT | 1.000 | 19.494 | 15.488 | 0 | 0 | -0.232 | | | | |
| 9 | TQMAX | 0.9999 | CAP | 1.000 | 1.4467 | 1.0895 | 0 | 0 | -0.287 | 1.38 | 2 | 2 | 3 |
| | | | ZSP | 0.999 | 1.3109 | 1.2218 | 0 | 0 | -0.071 | 0.34 | 4 | 3 | 4 |
| | | | AOAMAX | 0.929 | 1.2846 | 1.2516 | 0 | 0 | -0.026 | 0.13 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 1.1426 | 1.4041 | 0 | 0 | 0.208 | | | | |
| 10 | QXSEC | 0.9999 | CAP | 1.000 | 13.501 | 18.997 | 0 | 0 | 0.348 | 1.02 | 2 | 2 | 3 |
| | (1.0 sec) | | ZSP | 1.000 | 19.046 | 13.218 | 0 | 0 | -0.373 | 1.10 | 2 | 2 | 3 |
| | | | AOAMAX | 1.000 | 10.156 | 22.341 | 0 | 0 | 0.873 | 2.57 | 1 | 1 | 1 |
| | | | PLT | 1.000 | 18.811 | 13.473 | 0 | 0 | -0.340 | | | | |
| 11 | AOADMX | 0 | CAP | 1.000 | 13.307 | 18.203 | 0 | 0 | 0.318 | 1.15 | 2 | 2 | 3 |
| | | | ZSP | 1.000 | 18.513 | 12.767 | 0 | 0 | -0.380 | 1.37 | 2 | 2 | 3 |
| | | | AOAMAX | 1.000 | 9.4996 | 22.011 | 0 | 0 | 0.943 | 3.40 | 1 | 1 | 1 |
| | | | PLT | 1.000 | 17.802 | 13.537 | 0 | 0 | -0.277 | | | | |
| 12 | TADMAX | 0.9999 | CAP | 1.000 | 1.3605 | 1.0316 | 0 | 0 | -0.280 | 1.27 | 2 | 2 | 3 |
| | | | ZSP | 1.000 | 1.279 | 1.1062 | 0 | 0 | -0.146 | 0.66 | 3 | 3 | 4 |
| | | | AOAMAX | 0.984 | 1.1596 | 1.2325 | 0 | 0 | 0.061 | 0.28 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 1.0704 | 1.3322 | 0 | 0 | 0.221 | | | | |
| 13 | ADXSEC | 0.9999 | CAP | 1.000 | 12.14 | 17.21 | 0 | 0 | 0.356 | 0.94 | 2 | 3 | 4 |
| | (1.0 sec) | | ZSP | 1.000 | 17.345 | 11.783 | 0 | 0 | -0.396 | 1.05 | 2 | 2 | 3 |
| | | | AOAMAX | 1.000 | 9.0043 | 20.345 | 0 | 0 | 0.908 | 2.41 | 1 | 1 | 1 |
| | | | PLT | 1.000 | 17.226 | 11.911 | 0 | 0 | -0.377 | | | | |
| 18 | THTMAX | 0.9999 | CAP | 0.879 | 41.387 | 40.763 | 0 | 0 | -0.015 | 0.09 | 4 | 3 | 4 |
| | | | ZSP | 1.000 | 42.102 | 39.963 | 0 | 0 | -0.052 | 0.30 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 32.726 | 49.423 | 0 | 0 | 0.424 | 2.46 | 1 | 1 | 1 |
| | | | PLT | 1.000 | 44.439 | 37.431 | 0 | 0 | -0.172 | | | | |
| 19 | TTHTMX | 0.9999 | CAP | 0.689 | 7.8354 | 7.5809 | 0 | 0 | -0.033 | 2.31 | 4 | 1 | 4 |
| | | | ZSP | 1.000 | 6.9202 | 8.5618 | 0 | 0 | 0.214 | 15.02 | 2 | 1 | 2 |
| | | | AOAMAX | 1.000 | 10.77 | 4.6462 | 0 | 0 | -0.943 | 66.08 | 1 | 1 | 1 |
| | | | PLT | 0.511 | 7.761 | 7.651 | 0 | 0 | -0.014 | | | | |
| 20 | AOAMX | 0 | CAP | 1.000 | 56.843 | 55.884 | 0 | 0 | -0.017 | 2.19 | 4 | 1 | 4 |
| | | | ZSP | 1.000 | 58.774 | 53.753 | 0 | 0 | -0.089 | 11.51 | 4 | 1 | 4 |
| | | | AOAMAX | 1.000 | 41.001 | 71.727 | 0 | 0 | 0.589 | 75.80 | 1 | 1 | 1 |
| | | | PLT | 1.000 | 56.574 | 56.136 | 0 | 0 | -0.008 | | | | |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | TAOAMX | 0.9999 | CAP | 0.995 | 7.0243 | 6.3831 | 0 | 0 | -0.096 | 0.93 | 4 | 3 | 4 |
| | | | ZSP | 1.000 | 3.9277 | 9.7111 | 0 | 0 | 1.034 | 10.00 | 1 | 1 | 1 |
| | | | AOAMAX | 1.000 | 7.8628 | 5.5446 | 0 | 0 | -0.356 | 3.45 | 2 | 1 | 2 |
| | | | PLT | 0.964 | 6.371 | 7.0641 | 0 | 0 | 0.103 | | | | |
| 22 | AOAXSEC | 0 | CAP | 1.000 | 49.683 | 52.795 | 0 | 0 | 0.061 | 2.12 | 4 | 1 | 4 |
| | (3.0 sec) | | ZSP | 1.000 | 56.034 | 46.044 | 0 | 0 | -0.198 | 6.89 | 3 | 1 | 3 |
| | | | AOAMAX | 1.000 | 38.419 | 64.059 | 0 | 0 | 0.534 | 18.60 | 1 | 1 | 1 |
| | | | PLT | 1.000 | 51.944 | 50.475 | 0 | 0 | -0.029 | | | | |
| 38 | VDOTMX | 0.9999 | CAP | 0.061 | -5.4164 | -5.4091 | 0 | 0 | 0.001 | 0.00 | 4 | 3 | 4 |
| | | | ZSP | 1.000 | -6.0898 | -4.6793 | 0 | 0 | 0.267 | 0.67 | 2 | 3 | 4 |
| | | | AOAMAX | 1.000 | -1.6183 | -9.2071 | 0 | 0 | -2.757 | 6.88 | 1 | 1 | 1 |
| | | | PLT | 1.000 | -4.4032 | -6.5064 | 0 | 0 | -0.400 | | | | |

STEM 6 TEST 1 ANALYSIS D



STEM 6 TEST 1 ANALYSIS D

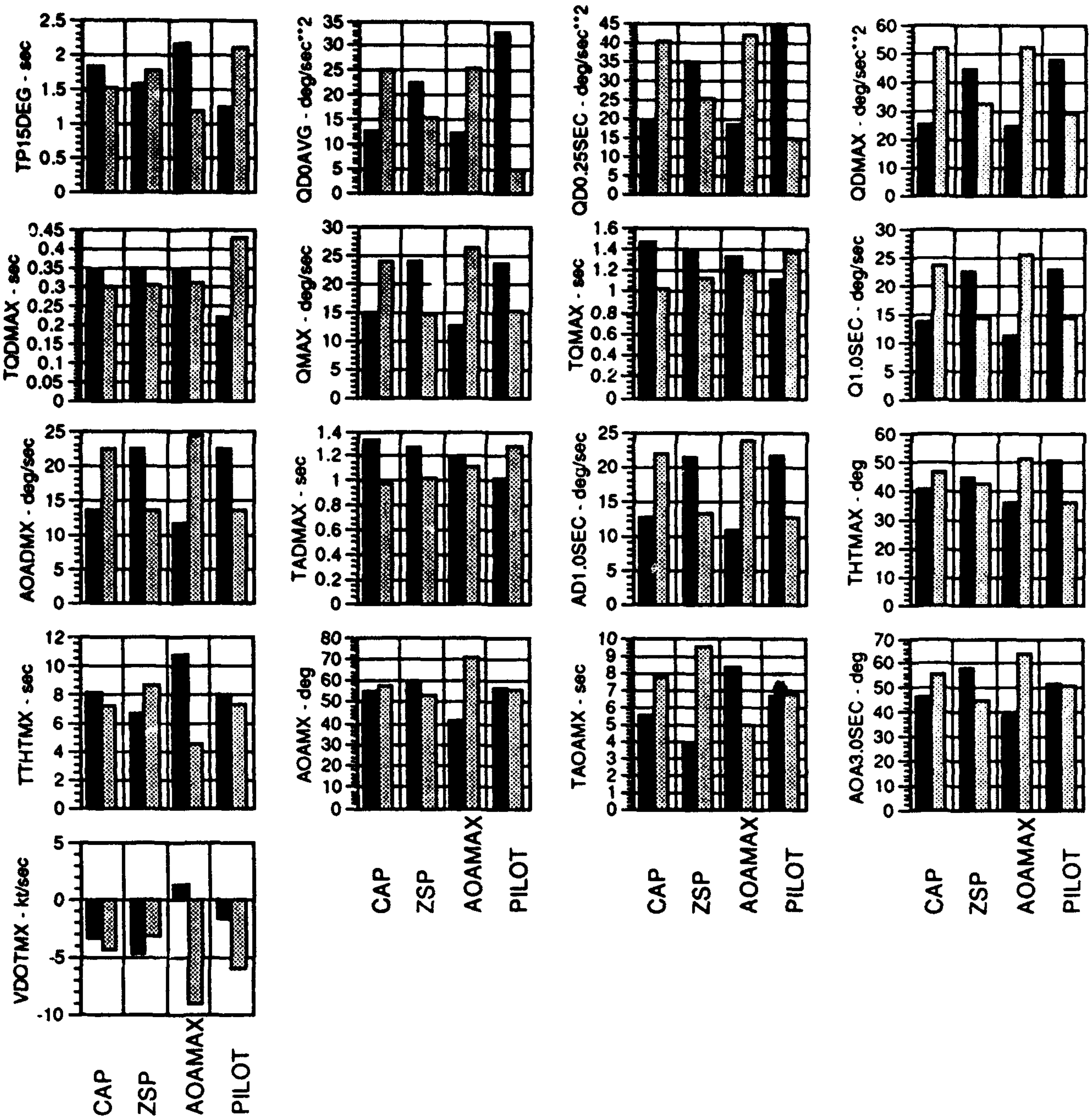


| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | TPXDEG | 0.9999 | CAP | 1.000 | 1.816 | 1.521 | 0 | 0 | -0.178 | 0.32 | 3 | 3 | 4 |
| | (15 deg) | | ZSP | 0.995 | 1.5689 | 1.7681 | 0 | 0 | 0.120 | 0.22 | 3 | 3 | 4 |
| | | | AOAMAX | 1.000 | 2.149 | 1.1881 | 0 | 0 | -0.628 | 1.13 | 1 | 2 | 2 |
| | | | PLT | 1.000 | 1.2367 | 2.1004 | 0 | 0 | 0.555 | | | | |
| 4 | QD0AVG | 0.9999 | CAP | 0.999 | 12.684 | 25.048 | 0 | 0 | 0.734 | 0.23 | 1 | 3 | 3 |
| | (0.25 sec) | | ZSP | 0.954 | 22.255 | 15.477 | 0 | 0 | -0.371 | 0.11 | 2 | 3 | 4 |
| | | | AOAMAX | 1.000 | 12.109 | 25.623 | 0 | 0 | 0.822 | 0.25 | 1 | 3 | 3 |
| | | | PLT | 1.000 | 32.783 | 4.9486 | 0 | 0 | -3.237 | | | | |
| 5 | QDXSEC | 0.9999 | CAP | 1.000 | 19.549 | 40.446 | 0 | 0 | 0.793 | 0.60 | 1 | 3 | 3 |
| | (0.25 sec) | | ZSP | 0.969 | 34.786 | 25.209 | 0 | 0 | -0.328 | 0.25 | 2 | 3 | 4 |
| | | | AOAMAX | 1.000 | 18.107 | 41.889 | 0 | 0 | 0.941 | 0.71 | 1 | 3 | 3 |
| | | | PLT | 1.000 | 44.945 | 15.05 | 0 | 0 | -1.326 | | | | |
| 6 | QDMAX | 0.9999 | CAP | 1.000 | 24.98 | 51.748 | 0 | 0 | 0.794 | 1.57 | 1 | 2 | 2 |
| | | | ZSP | 1.000 | 44.556 | 32.172 | 0 | 0 | -0.331 | 0.66 | 2 | 3 | 4 |
| | | | AOAMAX | 1.000 | 24.158 | 52.571 | 0 | 0 | 0.858 | 1.70 | 1 | 2 | 2 |
| | | | PLT | 1.000 | 47.509 | 29.219 | 0 | 0 | -0.505 | | | | |
| 7 | TQDMAX | 0.9987 | CAP | 0.789 | 0.3452 | 0.3002 | 0 | 0 | -0.140 | 0.19 | 4 | 3 | 4 |
| | | | ZSP | 0.763 | 0.3439 | 0.3015 | 0 | 0 | -0.132 | 0.18 | 4 | 3 | 4 |
| | | | AOAMAX | 0.563 | 0.3365 | 0.309 | 0 | 0 | -0.085 | 0.11 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 0.2158 | 0.4296 | 0 | 0 | 0.744 | | | | |
| 8 | QMAX | 0.9999 | CAP | 1.000 | 14.926 | 23.767 | 0 | 0 | 0.482 | 1.06 | 1 | 2 | 2 |
| | | | ZSP | 1.000 | 23.995 | 14.699 | 0 | 0 | -0.510 | 1.12 | 1 | 2 | 2 |
| | | | AOAMAX | 1.000 | 12.446 | 26.248 | 0 | 0 | 0.817 | 1.80 | 1 | 2 | 2 |
| | | | PLT | 1.000 | 23.53 | 15.164 | 0 | 0 | -0.454 | | | | |
| 9 | TQMAX | 0.9999 | CAP | 1.000 | 1.4744 | 1.021 | 0 | 0 | -0.376 | 1.82 | 2 | 2 | 3 |
| | | | ZSP | 1.000 | 1.3564 | 1.139 | 0 | 0 | -0.176 | 0.85 | 3 | 3 | 4 |
| | | | AOAMAX | 0.998 | 1.3198 | 1.1756 | 0 | 0 | -0.116 | 0.56 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 1.12 | 1.3754 | 0 | 0 | 0.207 | | | | |
| 10 | QXSEC | 0.9999 | CAP | 1.000 | 13.447 | 23.404 | 0 | 0 | 0.583 | 1.18 | 1 | 2 | 2 |
| | (1.0 sec) | | ZSP | 1.000 | 22.606 | 14.245 | 0 | 0 | -0.478 | 0.97 | 1 | 3 | 3 |
| | | | AOAMAX | 1.000 | 11.184 | 25.667 | 0 | 0 | 0.930 | 1.89 | 1 | 2 | 2 |
| | | | PLT | 1.000 | 22.721 | 14.13 | 0 | 0 | -0.493 | | | | |
| 11 | AOADMX | 0.9999 | CAP | 1.000 | 13.463 | 22.367 | 0 | 0 | 0.530 | 1.03 | 1 | 2 | 2 |
| | | | ZSP | 1.000 | 22.262 | 13.568 | 0 | 0 | -0.516 | 1.00 | 1 | 3 | 3 |
| | | | AOAMAX | 1.000 | 11.551 | 24.279 | 0 | 0 | 0.813 | 1.57 | 1 | 2 | 2 |
| | | | PLT | 1.000 | 22.266 | 13.564 | 0 | 0 | -0.516 | | | | |
| 12 | TADMAX | 0.9999 | CAP | 1.000 | 1.3285 | 0.971 | 0 | 0 | -0.319 | 1.39 | 2 | 2 | 3 |
| | | | ZSP | 1.000 | 1.2731 | 1.0265 | 0 | 0 | -0.217 | 0.95 | 2 | 3 | 4 |
| | | | AOAMAX | 0.957 | 1.1865 | 1.1131 | 0 | 0 | -0.064 | 0.28 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 1.02 | 1.2796 | 0 | 0 | 0.229 | | | | |
| 13 | ADXSEC | 0.9999 | CAP | 1.000 | 12.63 | 21.791 | 0 | 0 | 0.573 | 1.04 | 1 | 2 | 2 |
| | (1.0 sec) | | ZSP | 1.000 | 21.283 | 13.139 | 0 | 0 | -0.501 | 0.91 | 1 | 3 | 3 |
| | | | AOAMAX | 1.000 | 10.61 | 23.812 | 0 | 0 | 0.899 | 1.64 | 1 | 2 | 2 |
| | | | PLT | 1.000 | 21.625 | 12.796 | 0 | 0 | -0.549 | | | | |
| 18 | THTMAX | 0.9999 | CAP | 1.000 | 40.332 | 46.267 | 0 | 0 | 0.138 | 0.39 | 3 | 3 | 4 |
| | | | ZSP | 0.983 | 44.279 | 42.319 | 0 | 0 | -0.045 | 0.13 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 35.593 | 51.006 | 0 | 0 | 0.368 | 1.04 | 2 | 2 | 3 |
| | | | PLT | 1.000 | 50.738 | 35.861 | 0 | 0 | -0.354 | | | | |
| 19 | TTHTMX | 0.9999 | CAP | 0.917 | 8.1202 | 7.2002 | 0 | 0 | -0.121 | 1.39 | 3 | 2 | 4 |
| | | | ZSP | 0.999 | 6.6398 | 8.6806 | 0 | 0 | 0.271 | 3.14 | 2 | 1 | 2 |
| | | | AOAMAX | 1.000 | 10.807 | 4.5131 | 0 | 0 | -0.989 | 11.43 | 1 | 1 | 1 |
| | | | PLT | 0.797 | 7.9908 | 7.3296 | 0 | 0 | -0.086 | | | | |
| 20 | AOAMX | 0.9999 | CAP | 1.000 | 54.471 | 57.797 | 0 | 0 | 0.059 | 3.96 | 4 | 1 | 4 |
| | | | ZSP | 1.000 | 59.097 | 53.171 | 0 | 0 | -0.106 | 7.07 | 3 | 1 | 3 |
| | | | AOAMAX | 1.000 | 41.289 | 70.979 | 0 | 0 | 0.569 | 37.98 | 1 | 1 | 1 |
| | | | PLT | 1.000 | 56.554 | 55.714 | 0 | 0 | -0.015 | | | | |

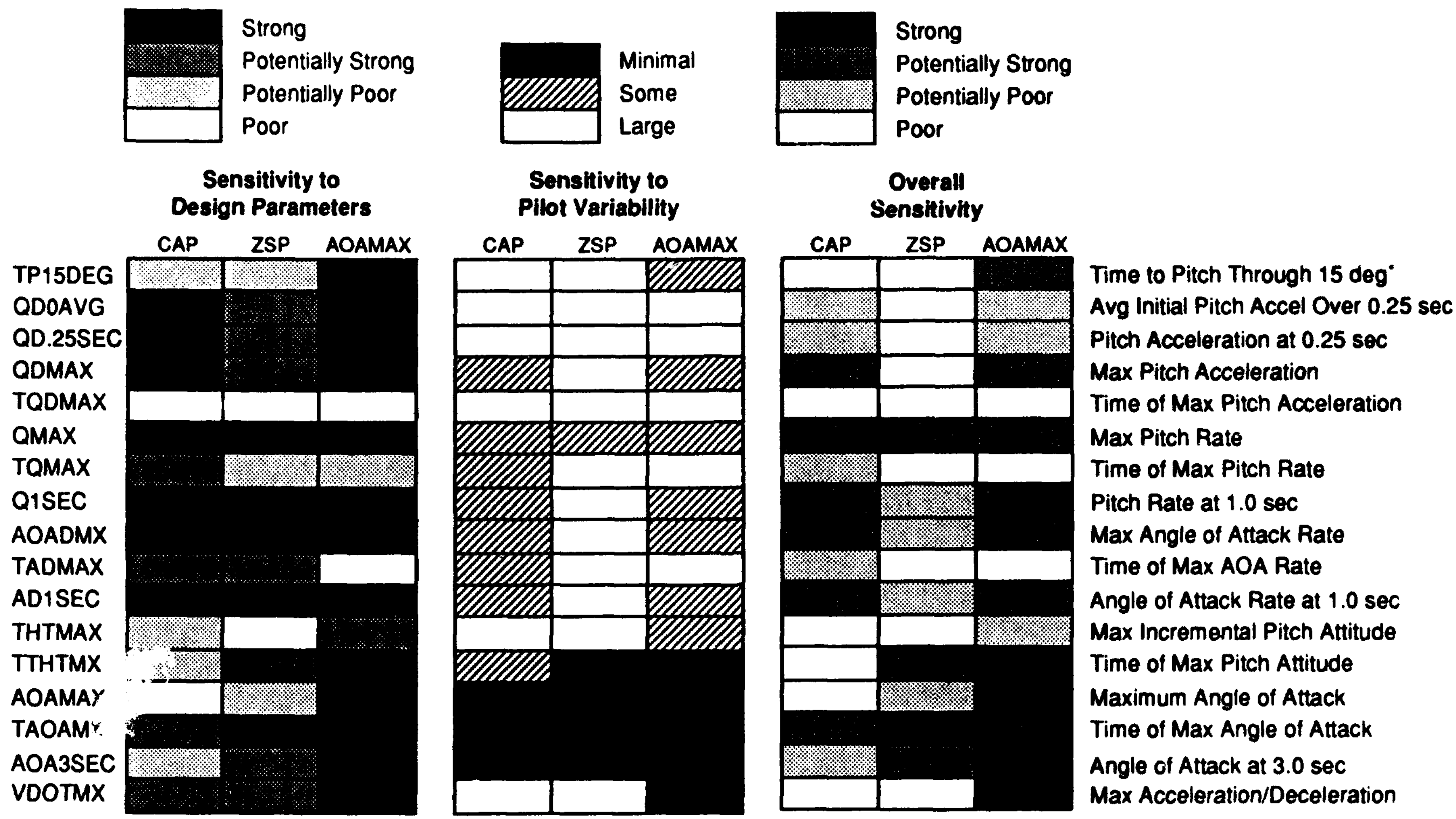
STEM 6 TEST 1 ANALYSIS E

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | TAOAMX | 0.9999 | CAP | 1.000 | 5.566 | 7.7669 | 0 | 0 | 0.339 | 14.17 | 2 | 1 | 2 |
| | | | ZSP | 1.000 | 3.8481 | 9.4848 | 0 | 0 | 1.030 | 43.00 | 1 | 1 | 1 |
| | | | AOAMAX | 1.000 | 8.3406 | 4.9923 | 0 | 0 | -0.536 | 22.39 | 1 | 1 | 1 |
| | | | PLT | 0.555 | 6.5867 | 6.7463 | 0 | 0 | 0.024 | | | | |
| 22 | AOAXSEC | 0.9999 | CAP | 1.000 | 46.519 | 55.971 | 0 | 0 | 0.186 | 10.59 | 3 | 1 | 3 |
| | (3.0 sec) | | ZSP | 1.000 | 57.664 | 44.827 | 0 | 0 | -0.254 | 14.48 | 2 | 1 | 2 |
| | | | AOAMAX | 1.000 | 38.393 | 64.098 | 0 | 0 | 0.535 | 30.46 | 1 | 1 | 1 |
| | | | PLT | 1.000 | 51.695 | 50.795 | 0 | 0 | -0.018 | | | | |
| 38 | VDOTMX | 0.9999 | CAP | 1.000 | -3.4763 | -4.4191 | 0 | 0 | -0.242 | 0.16 | 2 | 3 | 4 |
| | | | ZSP | 1.000 | -4.6741 | -3.2213 | 0 | 0 | 0.381 | 0.25 | 2 | 3 | 4 |
| | | | AOAMAX | 1.000 | 1.2289 | -9.1242 | 0 | 0 | -4.780 | 3.11 | 1 | 1 | 1 |
| | | | PLT | 1.000 | -1.8064 | -6.089 | 0 | 0 | -1.537 | | | | |

STEM 6 TEST 1 ANALYSIS E



STEM 6 TEST 1 ANALYSIS E



STEM 6 TEST 1
PILOT A
LONGITUDINAL CONFIGURATION 100
LATERAL CONFIGURATION 2

Much lighter stick forces during the setup this time. Not nearly the aft stick force required to get to 25 alpha. The longitudinal stick position change with alpha is not as significant because of lighter forces. The initial rate could have been better, the final rate was pretty good, and it had tremendous pitch authority - it took me up to 75 degrees. Pretty nice pitch performance. Even starting from low airspeed, I can bring the nose a long way up repeatably. Boy I could shoot somebody that is straight up there from just above stall speed. This is a good pointing airplane. It seems very spring loaded. All I have to do is start the stick forward and the nose comes right down. Kind of like a Cobra maneuver. But it is very springy in pitch around 25 degrees angle of attack and I think it would be difficult to track somebody. Even with full aft stick held in, the nose comes back down.

STEM 6 TEST 1
PILOT E
LONGITUDINAL CONFIGURATION 100
LATERAL CONFIGURATION 2

Real good initial pitch, and it gets up to 77°, that was a pretty good one. Good initial pitch, there's not a whole lot of change, it degrades gracefully as it approaches maximum and much higher angle of attack than the last one (Longitudinal configuration 101).

STEM 6 TEST 1
PILOT A
LONGITUDINAL CONFIGURATION 101
LATERAL CONFIGURATION 2

That's odd. It's real odd. Initial rate was a slow ramp. Final rate looked pretty good up to about 45 degrees and then it gave me another 10 degrees past that. Really slow onset. Almost like it was going into an AOA hang up or something. Very non-linear and therefore non-desirable. The initial rate is a little slow and then the rate looks okay until I get to 47 or 48. And then for some reason it's giving me this extra, that time it gave me an extra 5, up to about 54 degrees at a very slow rate with me just holding the stick full aft. Here we go. Again about 47 and then this 1 degree per second up to 53. I don't like that little tail on the end there and I think the initial pitch rate should be slightly higher. It should ramp up quicker.

STEM 6 TEST 1
PILOT E
LONGITUDINAL CONFIGURATION 101
LATERAL CONFIGURATION 2

Pretty much the same as the last one (Longitudinal configuration 102). It seems to have a little better initial pitch, but then it slows down markably and the last 5° is very slow. It gets up to about 54. In fact it basically stopped when it got within about 5° of maximum, then the last 5°

were very slow. The pitch rate seemed to be a little better initially than the last configuration, but it tends to stop when it gets within about 5° of max, and just creep on up after that.

STEM 6 TEST 1
PILOT A
LONGITUDINAL CONFIGURATION 102
LATERAL CONFIGURATION 2

This one takes a lot more aft stick to set up (than configuration 103). The stick is really traveling forward it seems as the alpha changes here in order to hold the test condition. Going uphill now. Very sluggish. Sluggish but it still ends up going a long way. Hit about 56 degrees pitch attitude. This is a real dog. It has a slow onset rate and then a very slow final pitch rate. If you were going after anything up here you'd just be.cursing and swearing at the doggy behavior. With this much stick force it feels like you have to fly the airplane with trim longitudinally. I mean I'm full aft stick there just to set up the maneuver. You need thrust to help you out. And yet the stick walks forward as my angle of attack comes down on my airspeed. It must be angle of attack related because the airspeed is hardly changing. I left my trim neutral, but if you had that kind of airplane you'd have to start running the trim back. You couldn't fight with that much aft force. Control harmony is terrible if you're pulling that hard longitudinally.

STEM 6 TEST 1
PILOT E
LONGITUDINAL CONFIGURATION 102
LATERAL CONFIGURATION 2

Real sluggish on the pitch but it just keeps on coming, to about 55°. It feels like an F-4. That one was a real sluggish pitch and a real slow rate all the way through. Not so good. Stick force is very high on that one too. Very sluggish. Seems to be much higher stick forces than the first configuration (Longitudinal configuration 103) as well as much slower response.

STEM 6 TEST 1
PILOT A
LONGITUDINAL CONFIGURATION 103
LATERAL CONFIGURATION 2

Initial response seems okay. Final rate seems a little bit slow but it's probably fine. That's such a dynamic maneuver in the air that you probably wouldn't want the pitch rates to be any higher than that. And you're going to such a wild condition, 70 degrees nose up. It'll be easier to judge the pitch rate when we're trying to capture a target. With no mission scenario in mind it's difficult to give you a qualitative feel for whether it was quick enough or too quick.

STEM 6 TEST 1
PILOT E
LONGITUDINAL CONFIGURATION 103
LATERAL CONFIGURATION 2

Pretty good initial pitch, it slowed down as it got a little higher, but it just kept on going. Good pitch, pretty constant, just slowed down at the end there. That was pretty good. Back up to about 69 degrees pitch, looks like pretty much the same thing. I liked that pitch real well, it held the pitch pretty well, just slowed down gracefully as approaching the top there. I could live with that.

STEM 6 TEST 1
PILOT A
LONGITUDINAL CONFIGURATION 115
LATERAL CONFIGURATION 2

It has a nice pitch rate, slowly tapering off. It is pretty tough to make any qualitative judgements on this without any scenario in mind. This more than anything resembles a missile break. I don't know why else I would put the stick in my lap and hold it that long. It has pretty good nose response. It could be faster but it has a good positive response. It feels like a good F-18 type of capable airplane. It has quite a bit of authority. Considering I am starting at 122 knots, it is a pretty impressive capability.

STEM 6 TEST 1
PILOT E
LONGITUDINAL CONFIGURATION 115
LATERAL CONFIGURATION 2

That one got up to about 60 degrees. I wasn't able to maintain the bank angle even with a two-handed straight back pull it still wants to wobble around. It has got pretty poor roll dynamics apparently, lightly damped. I am going from about 23 to 63 degrees pitch attitude, so we're getting about a 40 degree reserve.

STEM 6 TEST 1
PILOT A
LONGITUDINAL CONFIGURATION 116
LATERAL CONFIGURATION 2

That is sluggish. It is a doggy airplane. It is much, much too slow. It would not be suitable for any kind of tactical use. It feels like I am doing an IFR climb. This is a transport category response, not a fighter. That is an unacceptably low amount of pitch rate, and only 30° of pitch travel is not too impressive. It kind of weird the way it behaves. You continue to get a very slow rise in the nose after it feels like you are out of control power. If you would using this as a vertical turn in a fight, you would give up on it after about 15° of pitch and you would be trying to get your nose down. I end up sitting here with two hands on the stick wanting more. It is too slow, it is unacceptable.

STEM 6 TEST 1
PILOT E
LONGITUDINAL CONFIGURATION 116
LATERAL CONFIGURATION 2

This is very lightly damped in pitch. Very little initial pitch but it just keeps on going up very slowly to about 58 degrees. Very poor pitch characteristics.

STEM 6 TEST 1
PILOT A
LONGITUDINAL CONFIGURATION 117
LATERAL CONFIGURATION 2

The initial acceleration seems a little low and the maximum pitch rate seems a little low, but the eventual pitch angle is very impressive, it is getting up to 70°. It seems as if I reach a maximum pitch rate and it just keeps going. That could be dangerous because you could get yourself into a very low speed condition with your nose stuck up high. I am more use to a gradual degradation instead of a constant rate. It hesitates just a little, the inital acceleration is a little low. I would be happier if I could get to the maximum rate quicker. As a missile break maneuver, it feels a little sluggish in the inital response. As a high yo-yo maneuver, it is also a little sluggish. What I am envisioning as a maneuver for a tactical scenario is that I have a flight path overshoot in a 1 v 1 engagement. I have a significant engagement, so I am going to a quarter plane to get my nose up in the air. Then once I have my nose high enough, 60° to 70°, now I can think about slicing my nose down to reacquire the target now that I have stopped my forward travel. That is one of the reasons that I might do this. There I am at 122 knots, I have blown through the guy's six o'clock, or I am about to. So I plant it in my lap to start going vertical. And now I am going to come back down on him.

STEM 6 TEST 1
PILOT E
LONGITUDINAL CONFIGURATION 117
LATERAL CONFIGURATION 2

This has a considerably better initial pitch rate (than longitudinal configuration 116). It gets up to about 77 degrees and 77 alpha or so. Pretty good pitch performance on that one. The roll seems to be a little more lightly damped than the last configuration. The initial pitch rate is not great but it's fairly good. It gets up to 75 degrees. It's a pretty constant pitch rate all the way up rather than initial high pitch rate, then a very slow pitch rate as you drag the velocity vector up. Most of this seems to be pure pitch rather than dragging the velocity vector.

STEM 6 TEST 1
PILOT A
LONGITUDINAL CONFIGURATION 118
LATERAL CONFIGURATION 2

This is just about useless as a vertical turning maneuver because the pitch rate is so slow. The last 15° is tactically useless because it takes too long. Very sluggish response. You feel as if you are really at the edge

of the envelope. The nose feel like it really wants to go the other way. I actually accelerate a while with full aft stick since it is so slow. It will get its nose up, but it takes so long that it is not useful. I need better acceleration and rate so that I can use it tactically.

STEM 6 TEST 1
PILOT E
LONGITUDINAL CONFIGURATION 118
LATERAL CONFIGURATION 2

Much higher stick forces on this one. Much slower pitch dynamics. It becomes a velocity vector dragging maneuver up to about 56 degrees and about 40 alpha.

STEM 6 TEST 1
PILOT A
LONGITUDINAL CONFIGURATION 150
LATERAL CONFIGURATION 2

I think the onset of acceleration and the acceleration at 1 second would really show this to be bad. It is really slow getting going. I am pulling the stick into my lap for a reason, I want to get the nose moved. And I want it moved in the near future, not in 3-5 seconds. It takes too long to get to an acceptable rate. I would like a lot higher initial acceleration, longer sustained maximum pitch rate, and a higher pitch attitude. Basically, more response in a more timely manner.

STEM 6 TEST 1
PILOT E
LONGITUDINAL CONFIGURATION 150
LATERAL CONFIGURATION 2

This seems to be a fairly slow pitch response on that one. It only gets up to around 50 to 55 degrees normally. And about 40 degrees max angle of attack.

STEM 6 TEST 1
PILOT A
LONGITUDINAL CONFIGURATION 151
LATERAL CONFIGURATION 2

Good initial pitch acceleration, but it decayed too quickly to too low of a maximum rate. It is a nice snappy response, but then it peaks and decays immediately. It would be nice to maintain the maximum rate a little longer and get my nose a little higher. The initial acceleration is acceptable, it could be a little crisper. The rate that it gets to is also acceptable, but the length of time at that rate is too short. Again I am using a quarter plane to put this into a tactical scenario. And by quarter plane, I am reffering to the fact that you are getting yourself a quarter of a circle, or 90°, out of plane in order to maximumize the path length change. So that you can increase your nose-to-tail separation and minimize your flight path overshoot on a turning bogey. Basically, I am turning everything and pulling everything to try to stop the flight path overshoot

and get some of my energy turned into altitude. Then come back downhill towards the target, closer to his tail position.

STEM 6 TEST 1
PILOT E
LONGITUDINAL CONFIGURATION 151
LATERAL CONFIGURATION 2

This one looks pretty similar to the last one (longitudinal configuration 150). I can't really tell much difference. It gets up to about 40 alpha and 53 or so on the pitch. Seems to be very little difference between this one and the last configuration.

STEM 6 TEST 1
PILOT A
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 2

Not bad. A pretty reasonable initial acceleration. A little bit sluggish, but a very nice eventual rate. I could see myself pulling up into that maneuver and then ripping back down after somebody. It would be nice if my initial pitch onset was faster so that I knew my nose was coming up quicker. That is a nice amount of pitch change, it gets my nose up plenty high, so that it gets almost all of my velocity in the vertical and not much left in the horizontal.

STEM 6 TEST 1
PILOT E
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 2

This one is a more high powered configuration. We are getting up to about 67 degrees in pitch and alpha. It is more lightly damped in pitch and the initial pitch performance is higher and obviously it gets up to a higher maximum pitch in alpha. Much better pitch performance on this configuration.

STEM 6 TEST 1
PILOT A
LONGITUDINAL CONFIGURATION 153
LATERAL CONFIGURATION 2

What I find myself doing to simulate this quarter plane maneuver is checking back and I am looking to the side as if I were looking down at the bogey. I am watching the horizon rotate, I am not really looking at my pitch angle in degrees, or my airspeed. I am just judging my energy state by the changes in pitch rate. When my rate decays to a sufficient point, that is when I would make my decision to break and come back downhill. So that is why I want a good sustained pitch rate up to a good pitch attitude. That is very impressive performance, I end up at 75° pitch. Nice inital acceleration, nice final rate. I could really use that tactically. It really comes up crisply and maintains its maximum pitch rate for most of the maneuver. You would need to have this combined with good lateral response so that you don't end up just doing a Cobra maneuver. You want to

set the nose up in the air, stop your forward progress and at some point, slice it back down to the left or right. So this maneuver is a good initial stab at a quater plane maneuver, but of course it must be combined with a good lateral response. Because something like the Cobra maneuver has very little tactical utility. Maybe you could use it as a missile break, or maybe you could use it to spit somebody out. But basically, you have all your eggs in one basket. You slap the stick in your lap, lose 150 knots, and after its over then you are an energy grape. That is a good airplane. It has nice acceleration, nice sustained final rate, and a good range of motion.

STEM 6 TEST 1
PILOT E
LONGITUDINAL CONFIGURATION 153
LATERAL CONFIGURATION 2

This has got real good pitch acceleration. Up to over 70 alpha and 70 degrees of pitch or so. Real quick in pitch and it's less lightly damped (than longitudinal configuration 152). The lateral-directional also is a little bit difficult to keep the wings within 10 degrees of bank. I think I did but it was close. It's a little bit more difficult to control the bank angle at the high alphas. Up to about 75 degrees in both pitch and alpha. Real good pitch performance.

**Summary of Design Parameters Tested for STEM 6 TEST 2**

Test variables:

ZW: Indicates a variation $\zeta^*\omega$ (inverse of the pitch rate time constant). $\zeta^*\omega$ scheduled linearly with knots equivalent airspeed (KEAS) with the following value at 100 KEAS:

(-) 1.0 $sec^{-1}$, ($\tau$=1 sec)
(+) 2.0 $sec^{-1}$, ($\tau$=0.5 sec)

TV: Controls whether or not pitch thrust vectoring was enabled:

(-) No vectoring, results in the pitch rate system being AOA limited
(+) With vectoring

MALPHA: Indicates the longitudinal stability of the aircraft:

(-) -0.5 $sec^{-2}$, Stable
(+) 0.25, Unstable

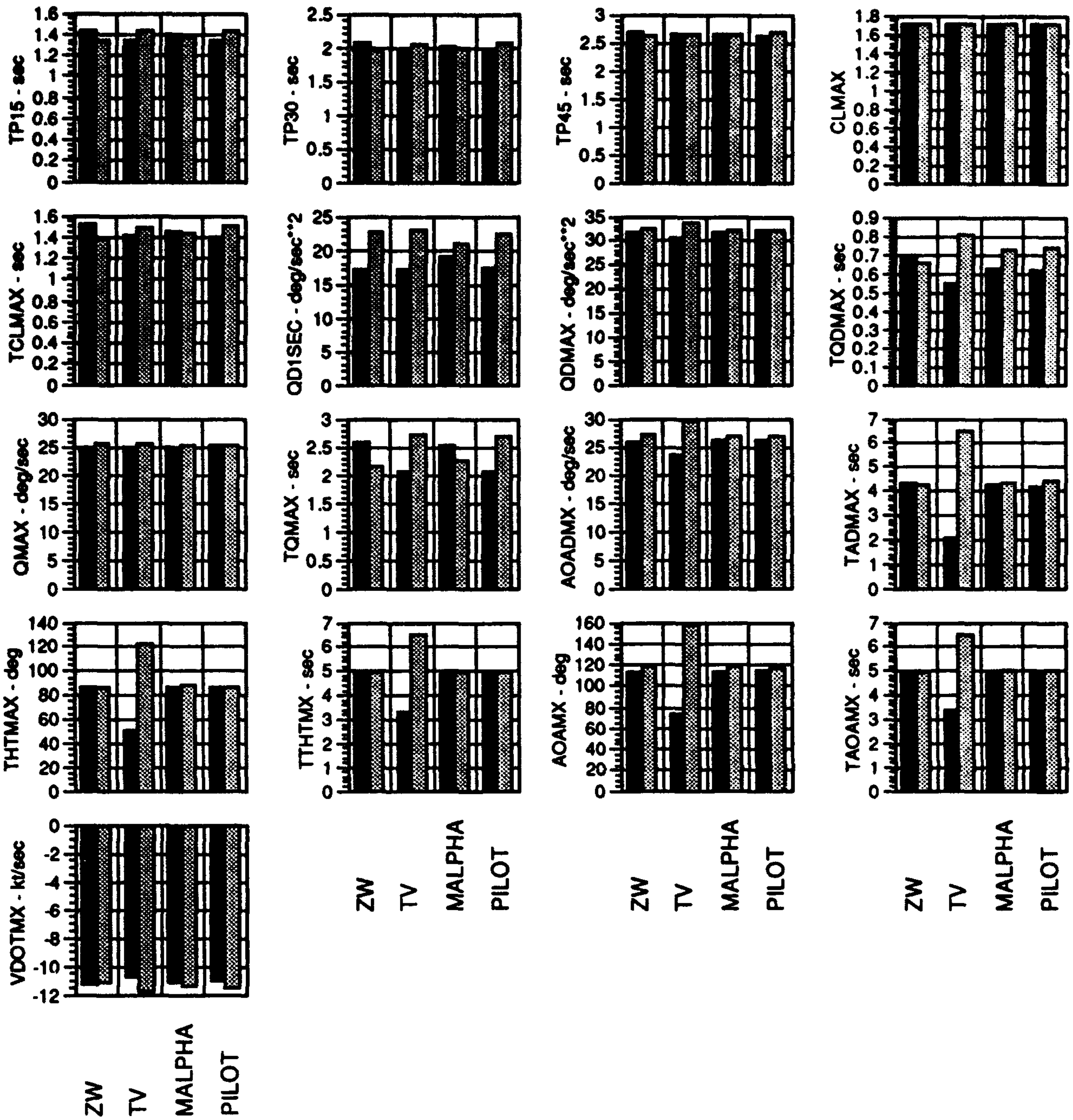
**Test Matrix**

| Lon Config | Lat Config | ZW | TV | MALPHA |
|---|---|---|---|---|
| 104 | 2 | 1.0 (-) | Off (-) | -0.5 (+) |
| 105 | 2 | 2.0 (+) | Off (-) | 0.25 (-) |
| 106 | 2 | 1.0 (-) | On (+) | 0.25 (-) |
| 107 | 2 | 2.0 (+) | On (+) | -0.5 (+) |

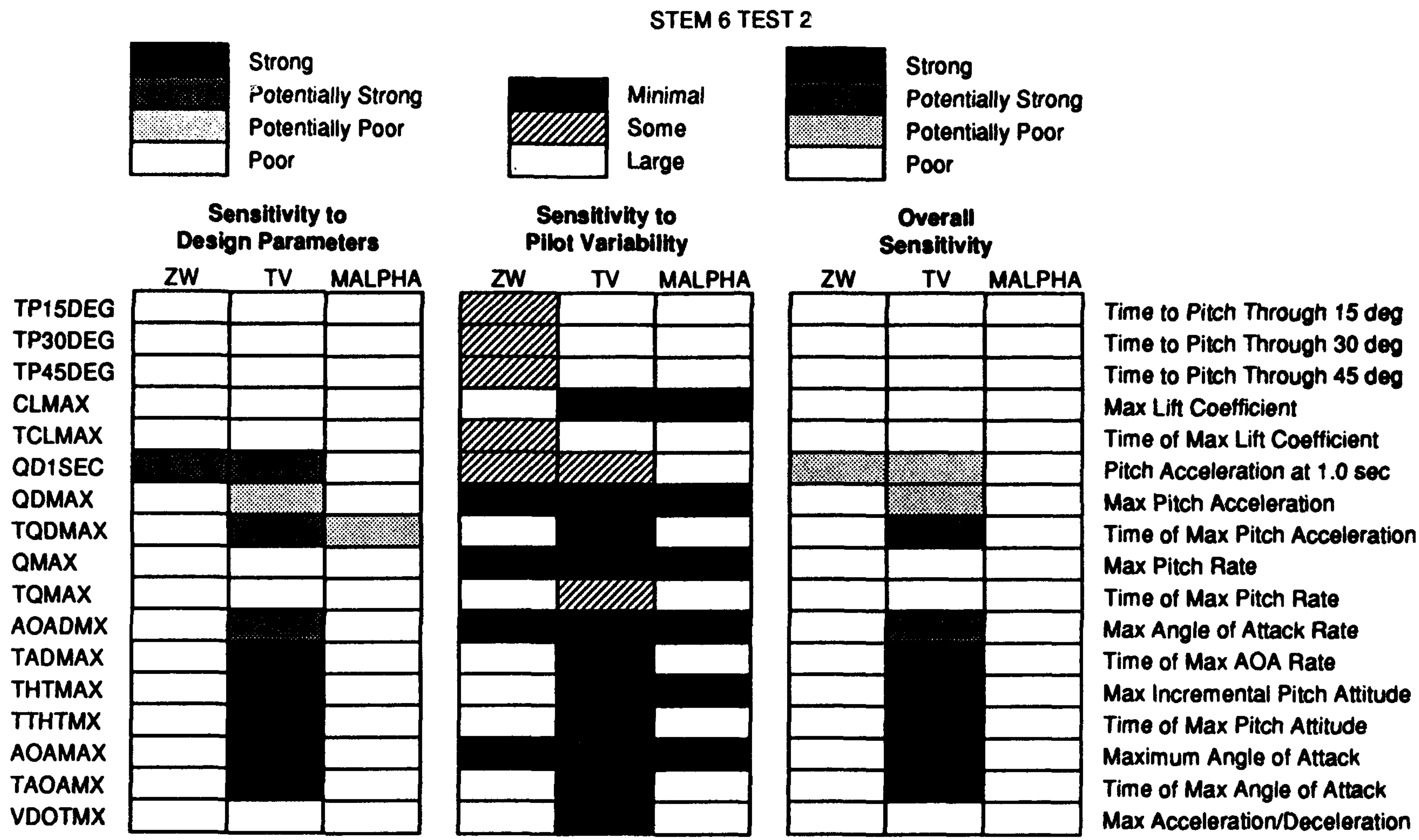
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ### | TP15DEG | 0.9813 | ZW | 0.991 | 1.4359 | 1.3374 | 0 | 0 | -0.071 | 1.03 | 4 | 2 | 4 |
| | | | TV | 0.967 | 1.3477 | 1.4256 | 0 | 0 | 0.056 | 0.81 | 4 | 3 | 4 |
| | | | MALPHA | 0.470 | 1.3974 | 1.3759 | 0 | 0 | -0.015 | 0.22 | 4 | 3 | 4 |
| | | | PLT | 0.989 | 1.3387 | 1.4346 | 0 | 0 | 0.069 | | | | |
| ### | TP30DEG | 0.9911 | ZW | 0.998 | 2.0718 | 1.9494 | 0 | 0 | -0.061 | 1.26 | 4 | 2 | 4 |
| | | | TV | 0.968 | 1.9711 | 2.0502 | 0 | 0 | 0.039 | 0.81 | 4 | 3 | 4 |
| | | | MALPHA | 0.341 | 2.0182 | 2.0031 | 0 | 0 | -0.008 | 0.16 | 4 | 3 | 4 |
| | | | PLT | 0.990 | 1.9619 | 2.0593 | 0 | 0 | 0.048 | | | | |
| ### | TP45DEG | 0.8715 | ZW | 0.973 | 2.7008 | 2.606 | 0 | 0 | -0.036 | 1.17 | 4 | 2 | 4 |
| | | | TV | 0.443 | 2.6418 | 2.6651 | 0 | 0 | 0.009 | 0.29 | 4 | 3 | 4 |
| | | | MALPHA | 0.542 | 2.6682 | 2.6387 | 0 | 0 | -0.011 | 0.37 | 4 | 3 | 4 |
| | | | PLT | 0.946 | 2.613 | 2.6939 | 0 | 0 | 0.030 | | | | |
| 2 | CLMAX | 0.3239 | ZW | 0.033 | 1.7173 | 1.7172 | 0 | 0 | 0.000 | 0.12 | 4 | 3 | 4 |
| | | | TV | 0.544 | 1.7177 | 1.7168 | 0 | 0 | -0.001 | 2.21 | 4 | 1 | 4 |
| | | | MALPHA | 0.752 | 1.718 | 1.7165 | 0 | 0 | -0.001 | 3.47 | 4 | 1 | 4 |
| | | | PLT | 0.264 | 1.717 | 1.7175 | 0 | 0 | 0.000 | | | | |
| 3 | TCLMAX | 0.9921 | ZW | 0.998 | 1.5186 | 1.3808 | 0 | 0 | -0.095 | 1.19 | 4 | 2 | 4 |
| | | | TV | 0.933 | 1.4138 | 1.4857 | 0 | 0 | 0.050 | 0.62 | 4 | 3 | 4 |
| | | | MALPHA | 0.252 | 1.4557 | 1.4437 | 0 | 0 | -0.008 | 0.10 | 4 | 3 | 4 |
| | | | PLT | 0.994 | 1.392 | 1.5075 | 0 | 0 | 0.080 | | | | |
| ### | QD1SEC | 0.9893 | ZW | 0.989 | 17.247 | 22.613 | 0 | 0 | 0.274 | 1.03 | 2 | 2 | 3 |
| | | | TV | 0.994 | 16.98 | 22.879 | 0 | 0 | 0.303 | 1.14 | 2 | 2 | 3 |
| | | | MALPHA | 0.684 | 18.961 | 20.899 | 0 | 0 | 0.097 | 0.37 | 4 | 3 | 4 |
| | | | PLT | 0.987 | 17.331 | 22.529 | 0 | 0 | 0.265 | | | | |
| 6 | QDMAX | 0.9999 | ZW | 1.000 | 31.601 | 32.526 | 0 | 0 | 0.029 | 6.34 | 4 | 1 | 4 |
| | | | TV | 1.000 | 30.439 | 33.688 | 0 | 0 | 0.102 | 22.33 | 3 | 1 | 3 |
| | | | MALPHA | 0.997 | 31.857 | 32.27 | 0 | 0 | 0.013 | 2.83 | 4 | 1 | 4 |
| | | | PLT | 0.773 | 31.991 | 32.136 | 0 | 0 | 0.005 | | | | |
| 7 | TQDMAX | 0.9999 | ZW | 0.779 | 0.7046 | 0.6622 | 0 | 0 | -0.062 | 0.34 | 4 | 3 | 4 |
| | | | TV | 1.000 | 0.5539 | 0.8129 | 0 | 0 | 0.393 | 2.17 | 2 | 1 | 2 |
| | | | MALPHA | 0.990 | 0.6349 | 0.7319 | 0 | 0 | 0.143 | 0.79 | 3 | 3 | 4 |
| | | | PLT | 0.998 | 0.622 | 0.7447 | 0 | 0 | 0.181 | | | | |
| 8 | QMAX | 0.9999 | ZW | 1.000 | 24.799 | 25.454 | 0 | 0 | 0.026 | 7.93 | 4 | 1 | 4 |
| | | | TV | 1.000 | 24.816 | 25.436 | 0 | 0 | 0.025 | 7.50 | 4 | 1 | 4 |
| | | | MALPHA | 0.999 | 24.964 | 25.289 | 0 | 0 | 0.013 | 3.93 | 4 | 1 | 4 |
| | | | PLT | 0.666 | 25.085 | 25.168 | 0 | 0 | 0.003 | | | | |
| 9 | TQMAX | 0.53 | ZW | 0.593 | 2.5948 | 2.1595 | 0 | 0 | -0.185 | 0.69 | 4 | 3 | 4 |
| | | | TV | 0.794 | 2.04 | 2.7144 | 0 | 0 | 0.290 | 1.08 | 4 | 2 | 4 |
| | | | MALPHA | 0.400 | 2.514 | 2.2404 | 0 | 0 | -0.116 | 0.43 | 4 | 3 | 4 |
| | | | PLT | 0.760 | 2.0652 | 2.6892 | 0 | 0 | 0.267 | | | | |
| 11 | AOADMX | 0.9999 | ZW | 0.941 | 25.773 | 27.299 | 0 | 0 | 0.058 | 3.35 | 4 | 1 | 4 |
| | | | TV | 1.000 | 23.642 | 29.43 | 0 | 0 | 0.221 | 12.84 | 2 | 1 | 2 |
| | | | MALPHA | 0.766 | 26.072 | 27 | 0 | 0 | 0.035 | 2.03 | 4 | 1 | 4 |
| | | | PLT | 0.448 | 26.308 | 26.764 | 0 | 0 | 0.017 | | | | |
| 12 | TADMAX | 0.9999 | ZW | 0.257 | 4.3051 | 4.2693 | 0 | 0 | -0.008 | 0.21 | 4 | 3 | 4 |
| | | | TV | 1.000 | 2.096 | 6.4783 | 0 | 0 | 1.384 | 35.24 | 1 | 1 | 1 |
| | | | MALPHA | 0.783 | 4.2182 | 4.3562 | 0 | 0 | 0.032 | 0.82 | 4 | 3 | 4 |
| | | | PLT | 0.863 | 4.203 | 4.3713 | 0 | 0 | 0.039 | | | | |
| 18 | THTMAX | 0.9999 | ZW | 0.669 | 87.007 | 86.67 | 0 | 0 | -0.004 | 0.64 | 4 | 3 | 4 |
| | | | TV | 1.000 | 51.308 | 122.37 | 0 | 0 | 0.983 | 161.79 | 1 | 1 | 1 |
| | | | MALPHA | 0.999 | 86.19 | 87.486 | 0 | 0 | 0.015 | 2.46 | 4 | 1 | 4 |
| | | | PLT | 0.864 | 86.575 | 87.102 | 0 | 0 | 0.006 | | | | |
| 19 | TTHTMX | 0.9999 | ZW | 0.019 | 4.9177 | 4.9152 | 0 | 0 | -0.001 | 0.02 | 4 | 3 | 4 |
| | | | TV | 1.000 | 3.3186 | 6.5144 | 0 | 0 | 0.727 | 26.52 | 1 | 1 | 1 |
| | | | MALPHA | 0.783 | 4.85 | 4.9829 | 0 | 0 | 0.027 | 0.99 | 4 | 3 | 4 |
| | | | PLT | 0.789 | 4.8491 | 4.9838 | 0 | 0 | 0.027 | | | | |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | AOAMX | 0.9999 | ZW | 0.882 | 112.85 | 117.96 | 0 | 0 | 0.044 | 4.06 | 4 | 1 | 4 |
| | | | TV | 1.000 | 74.026 | 156.78 | 0 | 0 | 0.823 | 75.42 | 1 | 1 | 1 |
| | | | MALPHA | 0.841 | 113.12 | 117.69 | 0 | 0 | 0.040 | 3.63 | 4 | 1 | 4 |
| | | | PLT | 0.311 | 114.77 | 116.03 | 0 | 0 | 0.011 | | | | |
| 21 | TAOAMX | 0.9999 | ZW | 0.055 | 4.9435 | 4.9362 | 0 | 0 | -0.001 | 0.04 | 4 | 3 | 4 |
| | | | TV | 1.000 | 3.3845 | 6.4953 | 0 | 0 | 0.699 | 21.23 | 1 | 1 | 1 |
| | | | MALPHA | 0.815 | 4.8682 | 5.0115 | 0 | 0 | 0.029 | 0.88 | 4 | 3 | 4 |
| | | | PLT | 0.864 | 4.8586 | 5.0212 | 0 | 0 | 0.033 | | | | |
| 38 | VDOTMX | 0.9999 | ZW | 0.906 | -11.307 | -11.171 | 0 | 0 | 0.012 | 0.31 | 4 | 3 | 4 |
| | | | TV | 1.000 | -10.696 | -11.783 | 0 | 0 | -0.097 | 2.52 | 4 | 1 | 4 |
| | | | MALPHA | 1.000 | -11.053 | -11.426 | 0 | 0 | -0.033 | 0.86 | 4 | 3 | 4 |
| | | | PLT | 1.000 | -11.023 | -11.456 | 0 | 0 | -0.039 | | | | |

STEM 6 TEST 2



TP15 - sec
TP30 - sec
TP45 - sec
CLMAX
TCLMAX - sec
QD1SEC - deg/sec**2
QDMAX - deg/sec**2
TQDMAX - sec
QMAX - deg/sec
TQMAX - sec
AOADMX - deg/sec
TADMAX - sec
THTMAX - deg
TTHTMX - sec
AOAMX - deg
TAOAMX - sec
VDOTMX - kt/sec
ZW
TV
MALPHA
PILOT


STEM 6 TEST 2
Strong
Potentially Strong
Potentially Poor
Poor
Minimal
Some
Large
Strong
Potentially Strong
Potentially Poor
Poor
Sensitivity to Design Parameters
Sensitivity to Pilot Variability
Overall Sensitivity
ZW
TV
MALPHA
ZW
TV
MALPHA
ZW
TV
MALPHA
TP15DEG
TP30DEG
TP45DEG
CLMAX
TCLMAX
QD1SEC
QDMAX
TQDMAX
QMAX
TQMAX
AOADMX
TADMAX
THTMAX
TTHTMX
AOAMAX
TAOAMX
VDOTMX
Time to Pitch Through 15 deg
Time to Pitch Through 30 deg
Time to Pitch Through 45 deg
Max Lift Coefficient
Time of Max Lift Coefficient
Pitch Acceleration at 1.0 sec
Max Pitch Acceleration
Time of Max Pitch Acceleration
Max Pitch Rate
Time of Max Pitch Rate
Max Angle of Attack Rate
Time of Max AOA Rate
Max Incremental Pitch Attitude
Time of Max Pitch Attitude
Maximum Angle of Attack
Time of Max Angle of Attack
Max Acceleration/Deceleration

STEM 6 TEST 2
PILOT A
LONGITUDINAL CONFIGURATION 104
LATERAL CONFIGURATION 2

This one is like flying a slinky. It went to 76, bounced down to 50, back up to 60 or something, down to 45 and then finally started to stabilize. Pretty undesirable. It allows a tremendous overshoot in pitch pointing but no precision so you could hurl your nose up into the air but it would fall back down of its own accord. So might be a good way to slow down but it would not be a suitable way to end up in a tracking solution.

STEM 6 TEST 2
PILOT E
LONGITUDINAL CONFIGURATION 104
LATERAL CONFIGURATION 2

Got up to about 75° and bounced off, that's the slinky mod. Good initial pitch rate, just bounces off of about 76° like it hit a brick wall. A slinky by any other name is still a slinky. Good initial pitch rate, stops very quickly and bounces off about 76° pitch.

STEM 6 TEST 2
PILOT A
LONGITUDINAL CONFIGURATION 105
LATERAL CONFIGURATION 2

It reached 72 degrees, but it is pretty springy. It bounced back down to 47, and back up again. A little bit of roll off to the right. Initial acceleration was good, rate was good. Not very steady, a lot of dynamics at the final pitch condition. Quite a spring, a lot of positive restoring force. The final rate could be a little bit faster. It gets to a rate and doesn't continue to accelerate. Very positive restoring force on the thing.

STEM 6 TEST 2
PILOT E
LONGITUDINAL CONFIGURATION 105
LATERAL CONFIGURATION 2

Reached about 76 degrees. Good initial pitch rate, bounced right off of 76 degrees and bobbles around 40 to 60. Pretty good initial pitch rate, bounces off 76 degrees and then bobbles up and down. It probably would not be a great guns tracking platform because of the overshoots, the bouncing around. It would be very difficult to control it to high angle of attack.

STEM 6 TEST 2
PILOT A
LONGITUDINAL CONFIGURATION 106
LATERAL CONFIGURATION 2

It goes over the top. Initial acceleration was a little slow, final rate was good. Takes it right through the vertical, alpha gets silly. Again the initial acceleration is a little sluggish, final rate is good. The

rate as I'm going through, about 60 degrees pitch, is the rate that I want but it takes that much pitch change to get to the rate so the initial acceleration is too slow.

STEM 6 TEST 2
PILOT E
LONGITUDINAL CONFIGURATION 106
LATERAL CONFIGURATION 2

You can stop that one. The pitch rate initially was about the same (as Longitudinal Configuration 105) but it just kept on going. And in fact the pitch rate seemed to build up going over the top. I'm having a lot of trouble keeping the nose going straight up, particularly as it approaches the vertical. The pitch rate remains fairly constant all the way across the top, pretty good rate.

STEM 6 TEST 2
PILOT A
LONGITUDINAL CONFIGURATION 107
LATERAL CONFIGURATION 2

Good initial rate, good final rate, it felt like it was going to slow down and stop me before I went through the vertical, but then it sustained enough rate to take me right through the vertical. It ended up taking me all the way around. That is so much pitch authority, I doubt if I could get it stopped in time to track somebody. I mean it just goes rocketing through. It's a hell of a slow speed loop.

STEM 6 TEST 2
PILOT E
LONGITUDINAL CONFIGURATION 107
LATERAL CONFIGURATION 2

Nice pitch rate, went right over the top. It was a little difficult to keep the wings level. Real good pitch rate, right over the top. And up the other side to about 35° high. It slows down a little bit going over the top but not much, pretty much real good initial pitch rate and it sustained almost maximum rate all the way across. I like it.

## Summary of Design Parameters Tested for STEM 6 TEST 3

Test variables:

CAP: Indicates a variation in CAP:

(-) 0.28, Level 1/2 boundary from MIL-STD-1797A

(+) 0.60. Within the Level 1 region from MIL-STD-1797A and generally good for acquisition

ZSP: A schedule of ZSP was implemented based on AOA:

For low AOA (≤10°), ZSP maintained at:

(-) 0.35, Level 1/2 boundary from MIL-STD-1797A

(+) 0.70, Within the Level 1 region from MIL-STD-1797A and generally good for acquisition

For high AOA (30°), ZSP maintained at:

(-) 0.6, Level 1/2 boundary for high AOA maneuvering from MCAIR research

(+) 1.2, Solid Level 1 value for high AOA maneuvering from MCAIR research

AOAMAX: Indicates a maximum load factor and AOA. This also indicates a variation in stick sensitivity:

For low speed (<Vc), maximum AOA set at:

(-) 40°, Aircraft can reach maximum lift but cannot reach post-stall

(+) 70°, Aircraft can be flown post-stall

For high speed (≥Vc), maximum load factor set at:

(-) 7g

(+) 9g

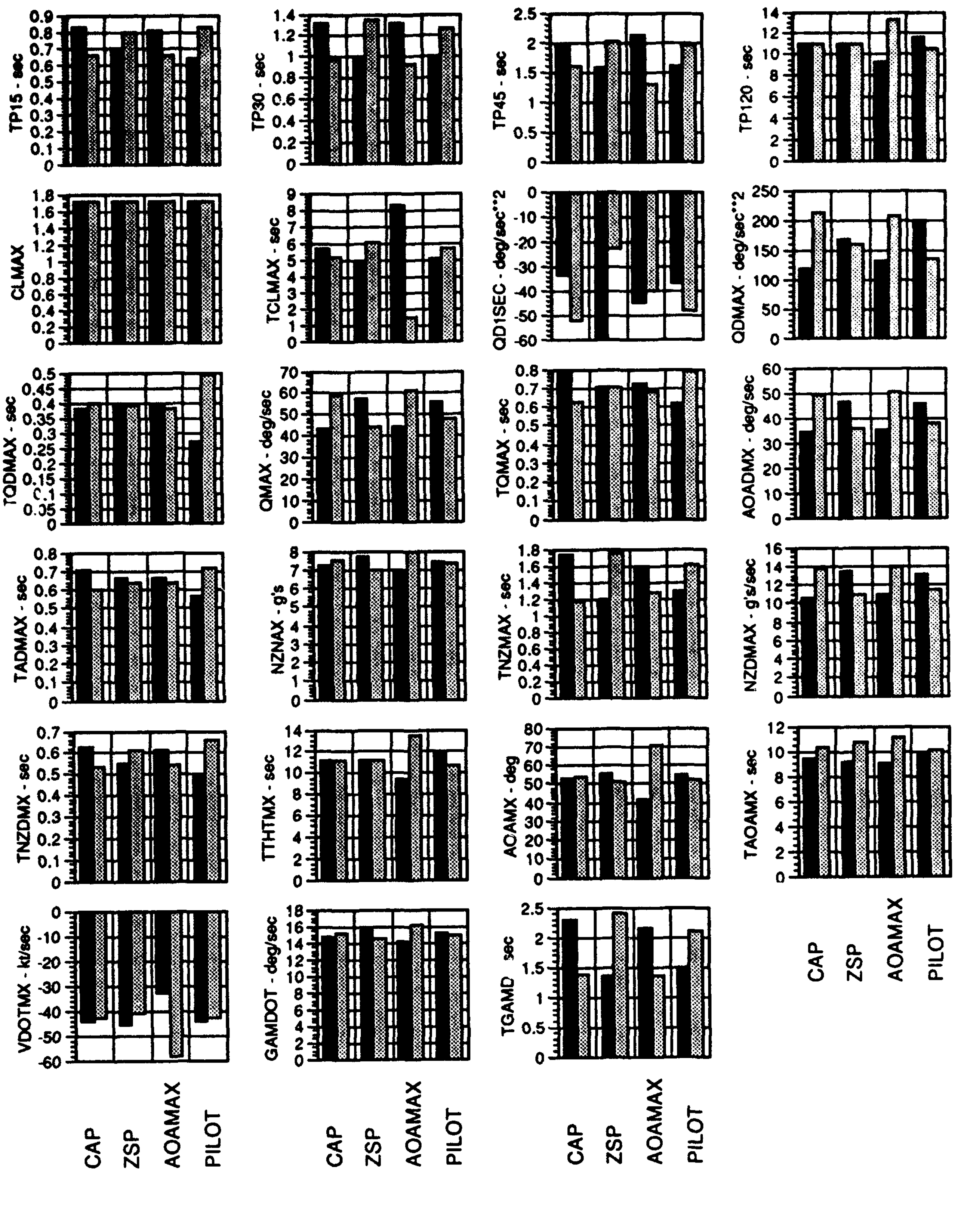
### Test Matrix

| Lon Config | Lat Config | CAP | ZSP | AOAMX(Nzmx) |
|---|---|---|---|---|
| 100 | 2 | 0.28 (-) | 0.35/0.6 (-) | 9g/70° (+) |
| 101 | 2 | 0.60 (+) | 0.35/0.6 (-) | 7g/40° (-) |
| 102 | 2 | 0.28 (-) | 0.70/1.2 (+) | 7g/40° (-) |
| 103 | 2 | 0.60 (+) | 0.70/1.2 (+) | 9g/70° (+) |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ### | TP15 | 0.9999 | CAP | 1.000 | 0.8321 | 0.6576 | 0 | 0 | -0.238 | 0.91 | 2 | 3 | 4 |
| | | | ZSP | 0.986 | 0.6958 | 0.802 | 0 | 0 | 0.142 | 0.55 | 3 | 3 | 4 |
| | | | AOAMAX | 1.000 | 0.8078 | 0.6589 | 0 | 0 | -0.205 | 0.79 | 2 | 3 | 4 |
| | | | PLT | 1.000 | 0.643 | 0.8321 | 0 | 0 | 0.261 | | | | |
| ### | TP30 | 0.9999 | CAP | 1.000 | 1.3244 | 0.9768 | 0 | 0 | -0.309 | 1.29 | 2 | 2 | 3 |
| | | | ZSP | 1.000 | 0.9923 | 1.3353 | 0 | 0 | 0.301 | 1.26 | 2 | 2 | 3 |
| | | | AOAMAX | 1.000 | 1.3111 | 0.9317 | 0 | 0 | -0.348 | 1.45 | 2 | 2 | 3 |
| | | | PLT | 1.000 | 1.0055 | 1.2749 | 0 | 0 | 0.240 | | | | |
| ### | TP45 | 0.9999 | CAP | 1.000 | 1.959 | 1.6114 | 0 | 0 | -0.197 | 0.94 | 3 | 3 | 4 |
| | | | ZSP | 1.000 | 1.5816 | 2.0228 | 0 | 0 | 0.249 | 1.19 | 2 | 2 | 3 |
| | | | AOAMAX | 1.000 | 2.1378 | 1.3044 | 0 | 0 | -0.514 | 2.47 | 1 | 1 | 1 |
| | | | PLT | 1.000 | 1.5889 | 1.9535 | 0 | 0 | 0.208 | | | | |
| ### | TP120 | 0.9989 | CAP | 0.051 | 11.044 | 11 | 0 | 0 | -0.004 | 0.04 | 4 | 3 | 4 |
| | | | ZSP | 0.060 | 11.042 | 10.998 | 0 | 0 | -0.004 | 0.04 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 9.3145 | 13.35 | 0 | 0 | 0.368 | 3.91 | 2 | 1 | 2 |
| | | | PLT | 0.874 | 11.581 | 10.543 | 0 | 0 | -0.094 | | | | |
| 2 | CLMAX | 0.9973 | CAP | 0.997 | 1.7091 | 1.7183 | 0 | 0 | 0.005 | 2.48 | 4 | 1 | 4 |
| | | | ZSP | 0.998 | 1.7187 | 1.7078 | 0 | 0 | -0.006 | 2.97 | 4 | 1 | 4 |
| | | | AOAMAX | 0.991 | 1.7105 | 1.718 | 0 | 0 | 0.004 | 2.02 | 4 | 1 | 4 |
| | | | PLT | 0.716 | 1.7157 | 1.712 | 0 | 0 | -0.002 | | | | |
| 3 | TCLMAX | 0.9999 | CAP | 0.570 | 5.659 | 5.1614 | 0 | 0 | -0.092 | 0.81 | 4 | 3 | 4 |
| | | | ZSP | 0.910 | 4.8708 | 6.0395 | 0 | 0 | 0.217 | 1.90 | 2 | 2 | 3 |
| | | | AOAMAX | 1.000 | 8.3011 | 1.468 | 0 | 0 | -2.739 | 24.02 | 1 | 1 | 1 |
| | | | PLT | 0.669 | 5.0805 | 5.6928 | 0 | 0 | 0.114 | | | | |
| ### | QD1SEC | 0.9999 | CAP | 0.996 | -33.416 | -52.303 | 0 | 0 | -0.463 | 1.69 | 1 | 2 | 2 |
| | | | ZSP | 1.000 | -59.962 | -22.907 | 0 | 0 | 1.118 | 4.08 | 1 | 1 | 1 |
| | | | AOAMAX | 0.534 | -44.96 | -39.996 | 0 | 0 | 0.117 | 0.43 | 4 | 3 | 4 |
| | | | PLT | 0.978 | -36.722 | -48.121 | 0 | 0 | -0.274 | | | | |
| 6 | QDMAX | 0.9999 | CAP | 1.000 | 117.73 | 211.57 | 0 | 0 | 0.620 | 1.50 | 1 | 2 | 2 |
| | | | ZSP | 0.405 | 169.71 | 158.74 | 0 | 0 | -0.067 | 0.16 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 133.38 | 207.28 | 0 | 0 | 0.455 | 1.10 | 1 | 2 | 2 |
| | | | PLT | 1.000 | 200.34 | 134.05 | 0 | 0 | -0.413 | | | | |
| 7 | TQDMAX | 0.9945 | CAP | 0.259 | 0.3821 | 0.396 | 0 | 0 | 0.036 | 0.06 | 4 | 3 | 4 |
| | | | ZSP | 0.092 | 0.3923 | 0.3853 | 0 | 0 | -0.018 | 0.03 | 4 | 3 | 4 |
| | | | AOAMAX | 0.218 | 0.3945 | 0.3817 | 0 | 0 | -0.033 | 0.05 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 0.268 | 0.4928 | 0 | 0 | 0.647 | | | | |
| 8 | QMAX | 0.9999 | CAP | 1.000 | 43.482 | 59.041 | 0 | 0 | 0.311 | 2.03 | 2 | 1 | 2 |
| | | | ZSP | 1.000 | 57.364 | 44.142 | 0 | 0 | -0.265 | 1.73 | 2 | 2 | 3 |
| | | | AOAMAX | 1.000 | 43.811 | 61.421 | 0 | 0 | 0.344 | 2.25 | 2 | 1 | 2 |
| | | | PLT | 1.000 | 55.485 | 47.642 | 0 | 0 | -0.153 | | | | |
| 9 | TQMAX | 0.9998 | CAP | 1.000 | 0.7898 | 0.6306 | 0 | 0 | -0.227 | 0.92 | 2 | 3 | 4 |
| | | | ZSP | 0.376 | 0.7066 | 0.7145 | 0 | 0 | 0.011 | 0.05 | 4 | 3 | 4 |
| | | | AOAMAX | 0.946 | 0.7345 | 0.6771 | 0 | 0 | -0.081 | 0.33 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 0.618 | 0.7892 | 0 | 0 | 0.247 | | | | |
| 11 | AOADMX | 0.9999 | CAP | 1.000 | 34.102 | 48.951 | 0 | 0 | 0.369 | 2.04 | 2 | 1 | 2 |
| | | | ZSP | 1.000 | 46.507 | 35.715 | 0 | 0 | -0.267 | 1.48 | 2 | 2 | 3 |
| | | | AOAMAX | 1.000 | 34.903 | 50.558 | 0 | 0 | 0.379 | 2.09 | 2 | 1 | 2 |
| | | | PLT | 1.000 | 45.569 | 38.061 | 0 | 0 | -0.181 | | | | |
| 12 | TADMAX | 0.9987 | CAP | 0.996 | 0.7051 | 0.5999 | 0 | 0 | -0.162 | 0.66 | 3 | 3 | 4 |
| | | | ZSP | 0.784 | 0.6637 | 0.6395 | 0 | 0 | -0.037 | 0.15 | 4 | 3 | 4 |
| | | | AOAMAX | 0.631 | 0.6611 | 0.6408 | 0 | 0 | -0.031 | 0.13 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 0.568 | 0.7249 | 0 | 0 | 0.246 | | | | |
| 14 | NZMAX | 0.9999 | CAP | 0.999 | 7.2491 | 7.5143 | 0 | 0 | 0.036 | 1.60 | 4 | 2 | 4 |
| | | | ZSP | 1.000 | 7.7057 | 7.0036 | 0 | 0 | -0.096 | 4.27 | 4 | 1 | 4 |
| | | | AOAMAX | 1.000 | 6.9792 | 7.9305 | 0 | 0 | 0.128 | 5.72 | 3 | 1 | 3 |
| | | | PLT | 0.922 | 7.4708 | 7.3053 | 0 | 0 | -0.022 | | | | |

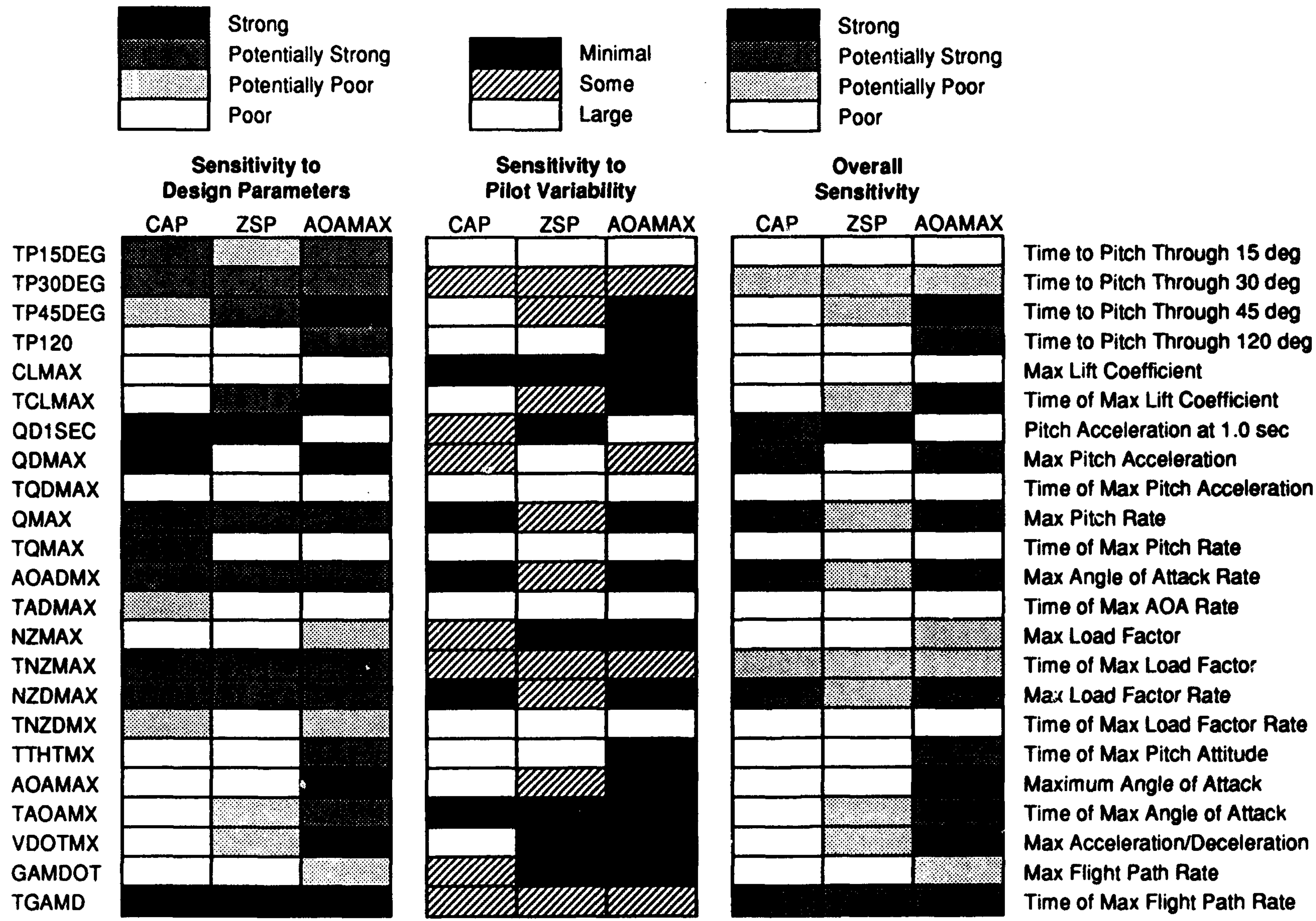
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | TNZMAX | 0.9999 | CAP | 1.000 | 1.7398 | 1.1845 | 0 | 0 | -0.394 | 1.80 | 2 | 2 | 3 |
| | | | ZSP | 1.000 | 1.203 | 1.7645 | 0 | 0 | 0.392 | 1.79 | 2 | 2 | 3 |
| | | | AOAMAX | 0.999 | 1.6011 | 1.2726 | 0 | 0 | -0.232 | 1.06 | 2 | 2 | 3 |
| | | | PLT | 0.995 | 1.293 | 1.6071 | 0 | 0 | 0.219 | | | | |
| 16 | NZDMAX | 0.9999 | CAP | 1.000 | 10.663 | 13.833 | 0 | 0 | 0.263 | 2.10 | 2 | 1 | 2 |
| | | | ZSP | 1.000 | 13.374 | 10.935 | 0 | 0 | -0.203 | 1.62 | 2 | 2 | 3 |
| | | | AOAMAX | 1.000 | 10.946 | 14.024 | 0 | 0 | 0.250 | 2.00 | 2 | 1 | 2 |
| | | | PLT | 1.000 | 13.074 | 11.54 | 0 | 0 | -0.125 | | | | |
| 17 | TNZDMX | 0.9996 | CAP | 0.997 | 0.6321 | 0.5268 | 0 | 0 | -0.183 | 0.61 | 3 | 3 | 4 |
| | | | ZSP | 0.867 | 0.5494 | 0.6145 | 0 | 0 | 0.112 | 0.37 | 4 | 3 | 4 |
| | | | AOAMAX | 0.982 | 0.6111 | 0.5362 | 0 | 0 | -0.131 | 0.44 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 0.4889 | 0.6571 | 0 | 0 | 0.300 | | | | |
| 19 | TTHTMX | 0.9988 | CAP | 0.012 | 11.135 | 11.146 | 0 | 0 | 0.001 | 0.01 | 4 | 3 | 4 |
| | | | ZSP | 0.042 | 11.158 | 11.121 | 0 | 0 | -0.003 | 0.04 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 9.4429 | 13.456 | 0 | 0 | 0.362 | 3.98 | 2 | 1 | 2 |
| | | | PLT | 0.864 | 11.686 | 10.673 | 0 | 0 | -0.091 | | | | |
| 20 | AOAMX | 0.9999 | CAP | 0.227 | 53.058 | 53.781 | 0 | 0 | 0.014 | 0.27 | 4 | 3 | 4 |
| | | | ZSP | 0.887 | 55.351 | 51.166 | 0 | 0 | -0.079 | 1.55 | 4 | 2 | 4 |
| | | | AOAMAX | 1.000 | 41.011 | 70.341 | 0 | 0 | 0.566 | 11.14 | 1 | 1 | 1 |
| | | | PLT | 0.726 | 54.883 | 52.166 | 0 | 0 | -0.051 | | | | |
| 21 | TAOAMX | 0.9999 | CAP | 0.948 | 9.4782 | 10.335 | 0 | 0 | 0.087 | 2.16 | 4 | 1 | 4 |
| | | | ZSP | 1.000 | 9.1708 | 10.765 | 0 | 0 | 0.161 | 4.02 | 3 | 1 | 3 |
| | | | AOAMAX | 1.000 | 9.0045 | 11.136 | 0 | 0 | 0.214 | 5.34 | 2 | 1 | 2 |
| | | | PLT | 0.396 | 9.693 | 10.089 | 0 | 0 | 0.040 | | | | |
| 38 | VDOTMX | 0.9999 | CAP | 0.268 | -43.948 | -43.108 | 0 | 0 | 0.019 | 0.45 | 4 | 3 | 4 |
| | | | ZSP | 0.938 | -45.662 | -41.038 | 0 | 0 | 0.107 | 2.49 | 3 | 1 | 3 |
| | | | AOAMAX | 1.000 | -32.947 | -57.957 | 0 | 0 | -0.595 | 13.87 | 1 | 1 | 1 |
| | | | PLT | 0.538 | -44.535 | -42.665 | 0 | 0 | 0.043 | | | | |
| 40 | GAMDOT | 0.9999 | CAP | 0.994 | 14.812 | 15.224 | 0 | 0 | 0.027 | 1.38 | 4 | 2 | 4 |
| | | | ZSP | 1.000 | 15.454 | 14.51 | 0 | 0 | -0.063 | 3.17 | 4 | 1 | 4 |
| | | | AOAMAX | 1.000 | 14.21 | 16.12 | 0 | 0 | 0.126 | 6.35 | 3 | 1 | 3 |
| | | | PLT | 0.925 | 15.179 | 14.88 | 0 | 0 | -0.020 | | | | |
| 41 | TGAMD | 0.9999 | CAP | 1.000 | 2.2859 | 1.373 | 0 | 0 | -0.532 | 1.51 | 1 | 2 | 2 |
| | | | ZSP | 1.000 | 1.3387 | 2.402 | 0 | 0 | 0.618 | 1.76 | 1 | 2 | 2 |
| | | | AOAMAX | 1.000 | 2.1745 | 1.359 | 0 | 0 | -0.488 | 1.39 | 1 | 2 | 2 |
| | | | PLT | 0.999 | 1.4972 | 2.1142 | 0 | 0 | 0.352 | | | | |

STEM 6 TEST 3



TP15 - sec
TP30 - sec
TP45 - sec
TP120 - sec
CLMAX
TCLMAX - sec
QD1SEC - deg/sec**2
QDMAX - deg/sec**2
TQDMAX - sec
QMAX - deg/sec
TQMAX - sec
AOADMX - deg/sec
TADMAX - sec
NZNAX - g's
TNZMAX - sec
NZDMAX - g's/sec
TNZDMX - sec
TTHTMX - sec
AOAMX - deg
TAOAMX - sec
VDOTMX - kt/sec
GAMDOT - deg/sec
TGAMD sec
CAP
ZSP
AOAMAX
PILOT

STEM 6 TEST 3


Strong
Potentially Strong
Potentially Poor
Poor
Minimal
Some
Large
Strong
Potentially Strong
Potentially Poor
Poor
Sensitivity to Design Parameters
Sensitivity to Pilot Variability
Overall Sensitivity
CAP
ZSP
AOAMAX
CAP
ZSP
AOAMAX
CAP
ZSP
AOAMAX
TP15DEG
TP30DEG
TP45DEG
TP120
CLMAX
TCLMAX
QD1SEC
QDMAX
TQDMAX
QMAX
TQMAX
AOADMX
TADMAX
NZMAX
TNZMAX
NZDMAX
TNZDMX
TTHTMX
AOAMAX
TAOAMX
VDOTMX
GAMDOT
TGAMD
Time to Pitch Through 15 deg
Time to Pitch Through 30 deg
Time to Pitch Through 45 deg
Time to Pitch Through 120 deg
Max Lift Coefficient
Time of Max Lift Coefficient
Pitch Acceleration at 1.0 sec
Max Pitch Acceleration
Time of Max Pitch Acceleration
Max Pitch Rate
Time of Max Pitch Rate
Max Angle of Attack Rate
Time of Max AOA Rate
Max Load Factor
Time of Max Load Factor
Max Load Factor Rate
Time of Max Load Factor Rate
Time of Max Pitch Attitude
Maximum Angle of Attack
Time of Max Angle of Attack
Max Acceleration/Deceleration
Max Flight Path Rate
Time of Max Flight Path Rate

STEM 6 TEST 3
PILOT B
LONGITUDINAL CONFIGURATION 100
LATERAL CONFIGURATION 2

Much more rapid AOA onset. It reaches about 90 degrees pitch, alpha takes up about 70. That appears to be as high as it wants to go in this case, then it drops back down. Lots of G's, lots of angle of attack, much quicker pitch rate. In general, the results are a faster pitch rate, faster AOA onset, and energy bleed to the point that it won't go past the vertical. Still fairly sensitive in pitch for small inputs. Looks like its not terribly well damped on the short period. Not as much G but there is a rapid AOA increase. Airspeed seems to bleed off just a bit faster than the previous one (longitudinal configuration 101). Still goes to the vertical and stops.

STEM 6 TEST 3
PILOT F
LONGITUDINAL CONFIGURATION 100
LATERAL CONFIGURATION 2

Its very goosey in pitch while setting up. The vertical pull up on that was a little bit different. It felt like it was a little bit more sluggish than the other one (longitudinal configuration 103). When we start off and I start going downhill I had a little PIO there, it felt like the pitch was real sensitive and then when I started to pull it seemed like the nose up pitch was a little bit slower, not that much slower, but slower than the other one. I'm getting some real PIOs during straight and level flight while going down to hit the entry. In other words I'm bobbling right around 15 degrees, and then when I start to pull it feels solid but it seems like its very sensitive in straight and level pitch. I got up to pure vertical, out of airspeed, couldn't make it over the top. Although it goes up vertical, it bleeds airspeed real quick.

STEM 6 TEST 3
PILOT B
LONGITUDINAL CONFIGURATION 101
LATERAL CONFIGURATION 2

This one feels a little looser in pitch while setting up. It hit 6.7 G's, 34 alpha. Much lower airspeed bleed. Over the top. That one doesn't look significantly different from the previous one (longitudinal configuration 102). Lets try it again and see if I pick something out. Little higher G, AOA still in the same ballpark, about 40. Airspeed bleed is slower, but not a great deal different in general from the previous configuration. The only thing that really jumps out to me on that one is that it looks a little bit different than the other one in the short period area which is not going to show up a great deal on that big step input. But for small inputs while setting up the dive angle, it appears to be a little bit looser pitch.

STEM 6 TEST 3
PILOT F
LONGITUDINAL CONFIGURATION 101
LATERAL CONFIGURATION 2

Okay this one made it over the top. Into a loop. Thats impressive. I had a little PIO right before I entered. Got to the top with 180 knots that time. Laterally its very stable as I hit the top. The other one when I got pure vertical I started losing lateral stability. The pitch rate seemed to be fairly smooth up to the vertical.

STEM 6 TEST 3
PILOT B
LONGITUDINAL CONFIGURATION 102
LATERAL CONFIGURATION 2

That was a little more sluggish (than longitudinal configuration 103), alpha is staying much lower. Its going all the way over the top. Slower AOA onset, slower pitch rate. It made it all the way over the top so it is bleeding energy slower. No difference in feel on the stick that I can see. And just for reference, I noted about 4-1/2 G's at some point. That one builds up to about 6-1/2 G's and bleeds off from there.

STEM 6 TEST 3
PILOT F
LONGITUDINAL CONFIGURATION 102
LATERAL CONFIGURATION 2

This pitch control seems a lot more stable, in fact its significantly more stable when setting up. Yeah thats a nice pitch. But the onset rate is much slower, most definitely. On that one it seemed like the onset rate was a lot slower which doesn't surprise me because the nose is more stable. Nose is a lot more stable going downhill, I don't have to deal with the little PIOs. Going up vertical seemed like it was slow, once it got going though the rate seemed okay. Not as fast as the one previous (longitudinal configuration 101). Pitch-wise the aircraft more stable as far as straight and level but on the onset pull its definitely has a slower onset rate.

STEM 6 TEST 3
PILOT B
LONGITUDINAL CONFIGURATION 103
LATERAL CONFIGURATION 2

We are pegging out the AOA at 69 degrees of pitch attitude. The final pitch attitude is in the area of 90 degrees, its a little hard to give you a good number because of the spinning HUD. It stops basically straight up. Its predictable, I don't see any unusual stick response, feels good.

STEM 6 TEST 3
PILOT F
LONGITUDINAL CONFIGURATION 103
LATERAL CONFIGURATION 2

Yeah we got some pitch here. Real goosey on the setup. Stick is centered throughout the pull and we're not gonna make it over the top. Lost so much energy with that pull. We had such a high pitch rate that we bled so much energy and couldn't get over the top. Lot of pitch authority, lot of airspeed bleed, looks like I'm not getting to the vertical. I went full aft stick and ran out pointing straight up 70 knots. Tremendous pitch rate onset. Way too much energy bleed to make it over the top. That one had tremendous pitch rate, it probably is the most pitch authority of all the ones we have seen

## Data Contents for STEM 7: Nose-Up Pitch Angle Capture

TEST 1: Maneuver tested at Vmin with AOA command systems, $\theta$=40° capture ($\approx\Delta\theta$=15°)

- Summary of Design Parameter Variations Tested
- Numerical Summary of Statistical Analysis
- Bar Graphs of Measures of Merit
- Design Parameter Correlations, Pilot Variability, and Overall Correlations
- Pilot Comments

TEST 2: Maneuver tested at Vmin with AOA command systems, $\theta$=55° capture ($\approx\Delta\theta$=30°)

- Summary of Design Parameter Variations Tested
- Numerical Summary of Statistical Analysis
- Bar Graphs of Measures of Merit
- Design Parameter Correlations, Pilot Variability, and Overall Correlations
- Pilot Comments

TEST 3: Maneuver tested at Vmin with pitch rate command, $\theta$=40° capture ($\approx\Delta\theta$=15°)

- Summary of Design Parameter Variations Tested
- Numerical Summary of Statistical Analysis
- Bar Graphs of Measures of Merit
- Design Parameter Correlations, Pilot Variability, and Overall Correlations
- Pilot Comments

TEST 4: Maneuver tested at Vmin with pitch rate command, $\theta$=120° capture ($\approx\Delta\theta$=95°)

- Summary of Design Parameter Variations Tested
- Numerical Summary of Statistical Analysis
- Bar Graphs of Measures of Merit
- Design Parameter Correlations, Pilot Variability, and Overall Correlations
- Pilot Comments

TEST 5: Maneuver tested at Vc with Nz/AOA command, $\theta$=15° capture ($\approx\Delta\theta$=30°)

- Summary of Design Parameter Variations Tested
- Numerical Summary of Statistical Analysis
- Bar Graphs of Measures of Merit
- Design Parameter Correlations, Pilot Variability, and Overall Correlations
- Pilot Comments

TEST 6: Maneuver tested at Vc with Nz/AOA command, $\theta$=30° capture ($\approx\Delta\theta$=45°)

- Summary of Design Parameter Variations Tested
- Numerical Summary of Statistical Analysis
- Bar Graphs of Measures of Merit
- Design Parameter Correlations, Pilot Variability, and Overall Correlations
- Pilot Comments

## Data Contents for STEM 7: Nose-Up Pitch Angle Capture

TEST 7: Maneuver tested at Vmin with AOA command systems, $\theta$=50° capture ($\approx\Delta\theta$=20°)

- Summary of Design Parameter Variations Tested

The following information is repeated for Analyses A, B, C, D, E, F, and G

- Numerical Summary of Statistical Analysis
- Bar Graphs of Measures of Merit
- Design Parameter Correlations, Pilot Variability, and Overall Correlations

The following information is located after Analyses A, B, C, D, E, F, and G

- Pilot Comments

Several statistical analyses are included to test variations on CAP, ZSP, LONSNS, TIMDEL, LONSHP, and TESTP and to compare the results from fractional factorial test matrices against full factorial matrices. If only one analysis is of interest, then Analysis D should be used. The following is a list of the analyses included for STEM 7 TEST 7:

| | |
|---|---|
| A | Fractional factorial of CAP, ZSP, LONSNS, and TIMDEL (pilots E and G flew all test points, pilots A and F flew only half of the test points) |
| B | Full factorial of CAP, ZSP, and LONSNS (pilots A, E, F, and G). |
| C | Variation on LONSHP (pilots A, E, F, and G). |
| D | Same as analysis A but with only pilot E and pilot G data (balanced test). |
| E | Half fraction of analysis B. |
| F | Opposite half fraction of analysis B. |
| G | Analysis B performed with TESTP as a parameter rather than PILOT. |

TEST 8: Maneuver tested at Vmin with pitch rate command, $\theta$=50° capture ($\approx\Delta\theta$=20°)

- Summary of Design Parameter Variations Tested
- Pilot Comments

TEST 9: Maneuver tested with generic transport aircraft, $\theta$=±2.5° captures

- Summary of Design Parameter Variations Tested
- Pilot Comments

## Summary of Design Parameters Tested for STEM 7 TEST 1

Test variables:

CAP: Indicates a variation in $\omega_{sp}$ since this is a low speed flight condition. $\omega_{sp}$ scheduled linearly with knots equivalent airspeed (KEAS) with the following value at 100 KEAS:

- (-) 0.729 rad/sec, Level 1/2 boundary for high AOA acquisition from MCAIR research
- (+) 1.067 rad/sec, Solid Level 1 value for high AOA acquisition from MCAIR research

ZSP: A schedule of ZSP was implemented based on AOA:

For low AOA (≤10°), ZSP maintained at:

- (-) 0.35, Level 1/2 boundary from MIL-STD-1797A
- (+) 0.70, Within the Level 1 region from MIL-STD-1797A and generally good for acquisition

For high AOA (30°), ZSP maintained at:

- (-) 0.6, Level 1/2 boundary for high AOA maneuvering from MCAIR research
- (+) 1.2, Solid Level 1 value for high AOA maneuvering from MCAIR research

LONSHP: Indicates whether or not non-linear stick shaping is being used:

- (-) No shaping, longitudinal dynamics do not vary with stick position
- (+) Shaping, $\omega_{sp}$ reduced and $\zeta_{sp}$ increased for for small incremental stick inputs

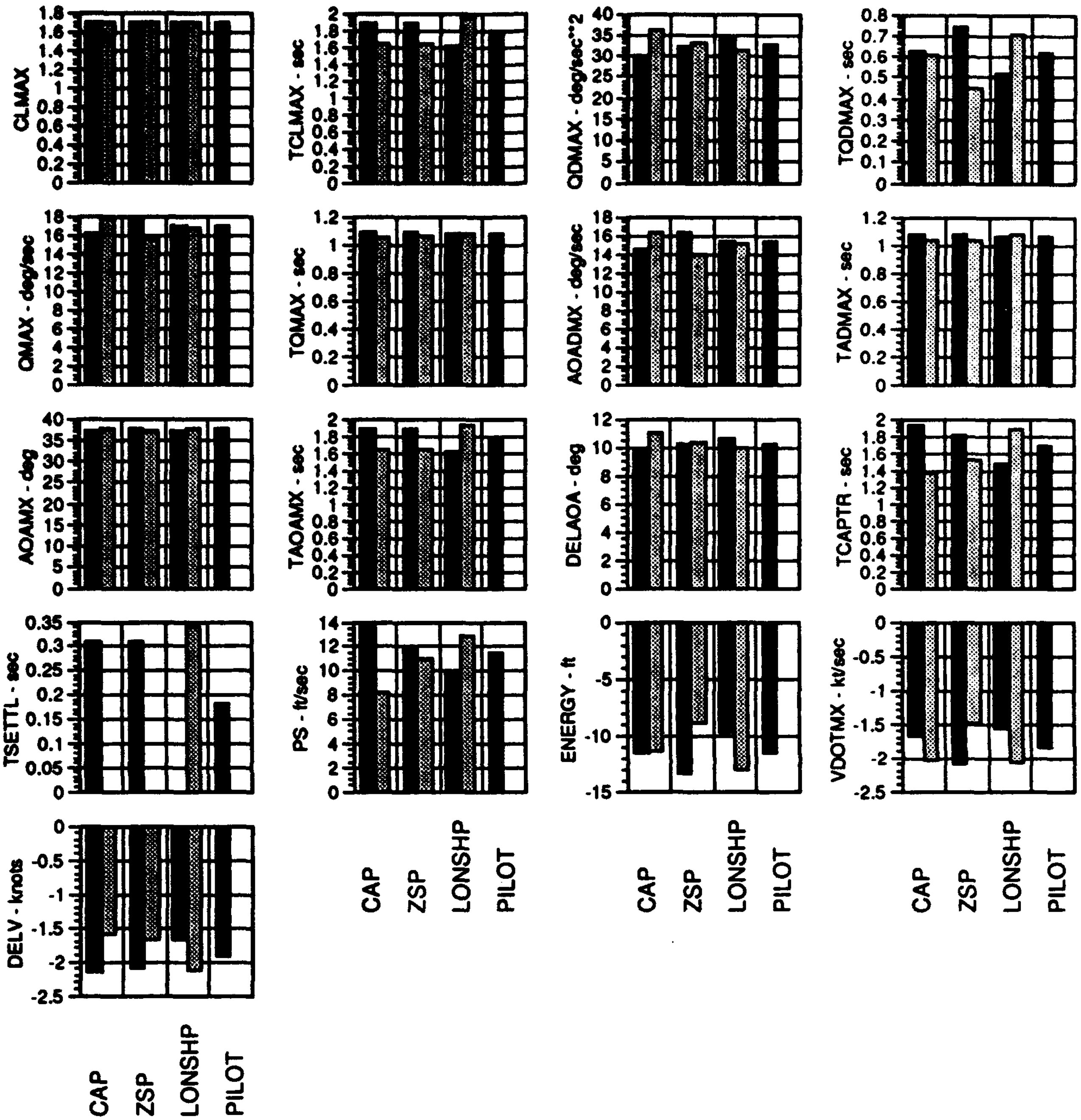
### Test Matrix

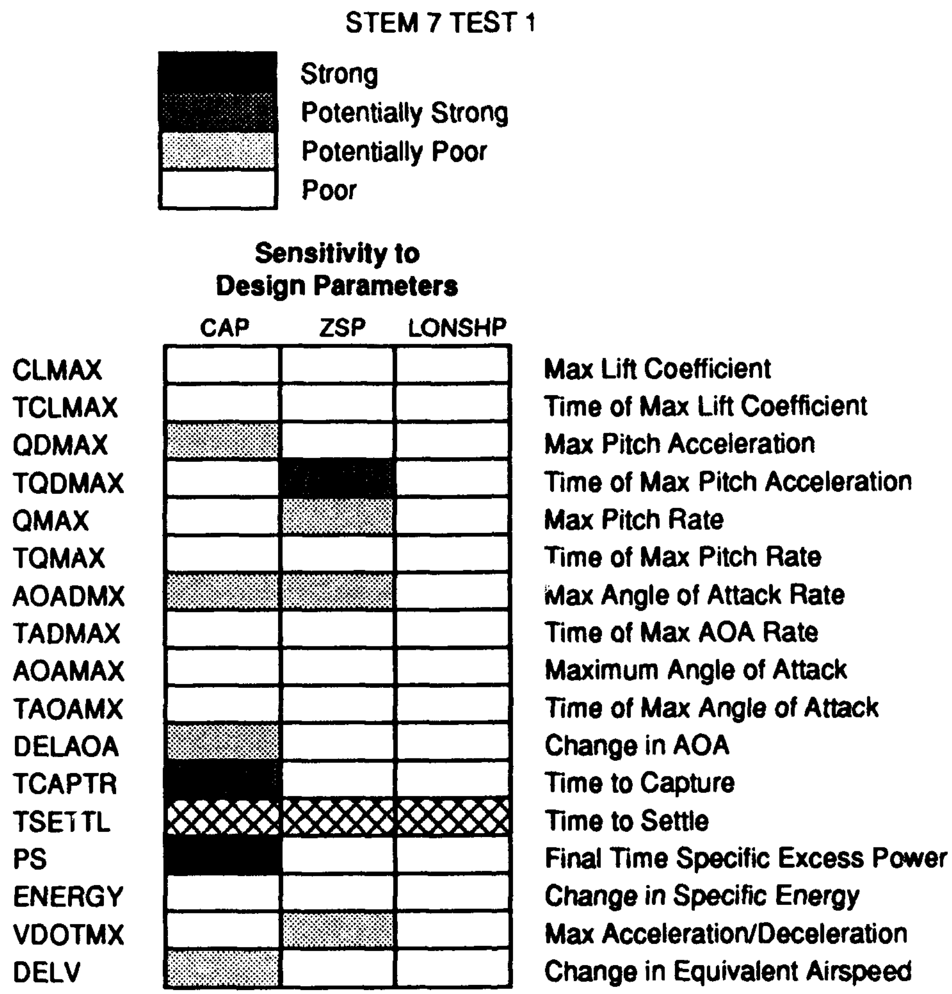
| Lon Config | Lat Config | CAP | ZSP | LONSHP |
|---|---|---|---|---|
| 108 | 2 | 0.28 (-) | 0.35/0.6 (-) | On (+) |
| 153 | 2 | 0.60 (+) | 0.35/0.6 (-) | Off (-) |
| 152 | 2 | 0.28 (-) | 0.70/1.2 (+) | Off (-) |
| 110 | 2 | 0.60 (+) | 0.70/1.2 (+) | On (+) |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | CLMAX | 0.8296 | CAP | 0.752 | 1.6946 | 1.7007 | 0 | 0 | 0.004 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.851 | 1.7003 | 1.6927 | 0 | 0 | -0.004 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.824 | 1.6933 | 1.7005 | 0 | 0 | 0.004 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 1.6971 | 1.6971 | 0 | 0 | 0.000 | | | | |
| 3 | TCLMAX | 0.8098 | CAP | 0.801 | 1.8929 | 1.6393 | 0 | 0 | -0.144 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.789 | 1.8929 | 1.6393 | 0 | 0 | -0.144 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.813 | 1.6126 | 1.9449 | 0 | 0 | 0.189 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 1.7885 | 1.7885 | 0 | 0 | 0.000 | | | | |
| 6 | QDMAX | 0.9924 | CAP | 0.999 | 30.226 | 36.451 | 0 | 0 | 0.188 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.278 | 32.492 | 33.214 | 0 | 0 | 0.022 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.708 | 34.22 | 31.518 | 0 | 0 | -0.082 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 32.789 | 32.789 | 0 | 0 | 0.000 | | | | |
| 7 | TQDMAX | 0.579 | CAP | 0.070 | 0.6279 | 0.6107 | 0 | 0 | -0.028 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.855 | 0.7429 | 0.4464 | 0 | 0 | -0.532 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.549 | 0.5187 | 0.7115 | 0 | 0 | 0.321 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 0.6208 | 0.6208 | 0 | 0 | 0.000 | | | | |
| 8 | QMAX | 0.9993 | CAP | 0.992 | 16.225 | 17.795 | 0 | 0 | 0.092 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | ZSP | 1.000 | 17.836 | 15.493 | 0 | 0 | -0.141 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.404 | 16.942 | 16.808 | 0 | 0 | -0.008 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 16.871 | 16.871 | 0 | 0 | 0.000 | | | | |
| 9 | TQMAX | 0.123 | CAP | 0.493 | 1.0929 | 1.0536 | 0 | 0 | -0.037 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.342 | 1.0879 | 1.0607 | 0 | 0 | -0.025 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.060 | 1.0687 | 1.0838 | 0 | 0 | 0.014 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 1.0767 | 1.0767 | 0 | 0 | 0.000 | | | | |
| 11 | AOADMX | 0.9994 | CAP | 0.994 | 14.592 | 16.232 | 0 | 0 | 0.107 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | ZSP | 1.000 | 16.239 | 13.879 | 0 | 0 | -0.158 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.366 | 15.328 | 15.213 | 0 | 0 | -0.008 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 15.267 | 15.267 | 0 | 0 | 0.000 | | | | |
| 12 | TADMAX | 0.2318 | CAP | 0.595 | 1.0829 | 1.0322 | 0 | 0 | -0.048 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.461 | 1.0779 | 1.0393 | 0 | 0 | -0.037 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.050 | 1.0562 | 1.0671 | 0 | 0 | 0.010 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 1.062 | 1.062 | 0 | 0 | 0.000 | | | | |
| 20 | AOAMX | 0.8402 | CAP | 0.743 | 37.267 | 37.747 | 0 | 0 | 0.013 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.861 | 37.722 | 37.097 | 0 | 0 | -0.017 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.837 | 37.148 | 37.746 | 0 | 0 | 0.016 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 37.465 | 37.465 | 0 | 0 | 0.000 | | | | |
| 21 | TAOAMX | 0.7811 | CAP | 0.767 | 1.8779 | 1.6393 | 0 | 0 | -0.136 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.777 | 1.8829 | 1.6321 | 0 | 0 | -0.143 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.803 | 1.6062 | 1.9338 | 0 | 0 | 0.187 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 1.7796 | 1.7796 | 0 | 0 | 0.000 | | | | |
| 23 | DELAOA | 0.7393 | CAP | 0.935 | 9.7463 | 10.971 | 0 | 0 | 0.119 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.177 | 10.179 | 10.353 | 0 | 0 | 0.017 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.463 | 10.566 | 9.9701 | 0 | 0 | -0.058 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 10.251 | 10.251 | 0 | 0 | 0.000 | | | | |
| 25 | TCAPTR | 0.8556 | CAP | 0.944 | 1.9179 | 1.3679 | 0 | 0 | -0.344 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.694 | 1.8129 | 1.5178 | 0 | 0 | -0.179 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.636 | 1.4937 | 1.8671 | 0 | 0 | 0.225 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 1.6914 | 1.6914 | 0 | 0 | 0.000 | | | | |
| 26 | TSETTL | 0.9154 | CAP | 0.901 | 0.31 | 0 | 0 | 0 | 0.000 | #NUM! | 4 | #NUM! | #NUM! |
| | | | ZSP | 0.892 | 0.31 | 0 | 0 | 0 | 0.000 | #NUM! | 4 | #NUM! | #NUM! |
| | | | LONSHP | 0.832 | 0 | 0.3444 | 0 | 0 | 0.000 | #NUM! | 4 | #NUM! | #NUM! |
| | | | PLT | -999.000 | 0.1824 | 0.1824 | 0 | 0 | 0.000 | | | | |
| 36 | PS | 0.8222 | CAP | 0.957 | 13.674 | 8.1861 | 0 | 0 | -0.536 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.214 | 11.758 | 10.923 | 0 | 0 | -0.074 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.564 | 9.8723 | 12.785 | 0 | 0 | 0.261 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 11.414 | 11.414 | 0 | 0 | 0.000 | | | | |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 37 | ENERGY | 0.233 | CAP | 0.032 | -11.63 | -11.428 | 0 | 0 | 0.017 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.620 | -13.37 | -8.9425 | 0 | 0 | 0.413 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.420 | -9.7495 | -13.144 | 0 | 0 | -0.303 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | -11.547 | -11.547 | 0 | 0 | 0.000 | | | | |
| 38 | VDOTMX | 0.7129 | CAP | 0.607 | -1.6801 | -2.0483 | 0 | 0 | -0.199 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.828 | -2.0753 | -1.4837 | 0 | 0 | 0.342 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.732 | -1.5678 | -2.0663 | 0 | 0 | -0.280 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | -1.8317 | -1.8317 | 0 | 0 | 0.000 | | | | |
| 39 | DELV | 0.6329 | CAP | 0.821 | -2.1547 | -1.5824 | 0 | 0 | 0.314 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.621 | -2.0769 | -1.6936 | 0 | 0 | 0.205 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.547 | -1.679 | -2.1325 | 0 | 0 | -0.241 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | -1.9191 | -1.9191 | 0 | 0 | 0.000 | | | | |

STEM 7 TEST 1


CLMAX
TCLMAX - sec
QDMAX - deg/sec**2
TQDMAX - sec
QMAX - deg/sec
TQMAX - sec
AOADMX - deg/sec
TADMAX - sec
AOAMX - deg
TAOAMX - sec
DELAOA - deg
TCAPTR - sec
TSETTL - sec
PS - ft/sec
ENERGY - ft
VDOTMX - kt/sec
DELV - knots
CAP
ZSP
LONSHP
PILOT




Note: Data available for only a single pilot, therefore, sensitivity to pilot variability and overall sensitivity not shown.

STEM 7 TEST 1
PILOT E
LONGITUDINAL CONFIGURATION 108
LATERAL CONFIGURATION 2

What I'm doing is aggressively using full aft stick and then basically as soon as it gets started moving, I'm trying to stop it aggressively. It's doing it that way. Sometimes I'll overshoot it once, but I think that's probably the fastest way overall. It's a little difficult to get it to stop once the pitch rate gets up that high. The initial pitch rate is real quick. You have to be aggressive to stop it where you want it. Basically I'm using a kind of bang-bang controls on this thing, rather than trying to sneak up on it. The onset pitch is good and it's difficult to stop at the maximum rate. A little difficult to capture. I think with more practice I could get it and this would be minimum time, but the way I'm doing, I probably need to back off a little bit.

STEM 7 TEST 1
PILOT E
LONGITUDINAL CONFIGURATION 153
LATERAL CONFIGURATION 2

I'm not going to be able to do full stick on this one. Initial pitch onset is quicker on this one and it's more difficult to stop. Just partial stick--about half stick or so, seems to be about right and then the pitch doesn't build up so much that it makes it fairly easy to capture. Basically, the best technique on this is about half stick and then rates don't build up so badly that it's difficult to stop and then it's pretty easy to capture. If I had done it the same way on the last one (longitudinal configuration 108), it would have probably been quicker too overall. Pretty good dynamics on that.

STEM 7 TEST 1
PILOT E
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 2

That's much slower on the dynamics. I can go full aft stick with this one. The initial onset is very slow and it builds up fairly slowly. I actually undershot that one, starting with full aft stick, so it stops rather quickly once you come off the aft stop. The dynamics on that one are slow--much slower and so you can be real aggressive on the pull up and still be able to stop it. As far as tactically, the pitch rate is--after seeing the other two, this one is probably a little inadequate, but if we had started with this one, I'd have probably said it was fine. Pretty good dynamics overall.

STEM 7 TEST 1
PILOT E
LONGITUDINAL CONFIGURATION 110
LATERAL CONFIGURATION 2

This one is quicker and a little more difficult to capture. Quicker on the onset, a little more difficult to capture, but you can probably still use full aft stick or almost full aft stick. Probably going to have to nurse

this one. I'll try sneaking up on it this time. Yeah, this one is fast enough, but I can't go full aft stick and still be able to capture it decently. It stops real nice at the rate that you build up at about half aft stick. It's initial pitch rate is good--it's better than the last one (longitudinal configuration 152). It stops real nicely but you can't use full aft stick on this particular distance. At least I can't use full aft stick and expect to be able to stop it half way decently.

## Summary of Design Parameters Tested for STEM 7 TEST 2

Test variables:

CAP: Indicates a variation in $\omega_{sp}$ since this is a low speed flight condition. $\omega_{sp}$ scheduled linearly with knots equivalent airspeed (KEAS) with the following value at 100 KEAS:

(-) 0.729 rad/sec, Level 1/2 boundary for high AOA acquisition from MCAIR research

(+) 1.067 rad/sec, Solid Level 1 value for high AOA acquisition from MCAIR research

ZSP: A schedule of ZSP was implemented based on AOA:

For low AOA ($\leq 10°$), ZSP maintained at:

(-) 0.35, Level 1/2 boundary from MIL-STD-1797A

(+) 0.70, Within the Level 1 region from MIL-STD-1797A and generally good for acquisition

For high AOA (30°), ZSP maintained at:

(-) 0.6, Level 1/2 boundary for high AOA maneuvering from MCAIR research

(+) 1.2, Solid Level 1 value for high AOA maneuvering from MCAIR research

LONSHP: Indicates whether or not non-linear stick shaping is being used:

(-) No shaping, longitudinal dynamics do not vary with stick position

(+) Shaping, $\omega_{sp}$ reduced and $\zeta_{sp}$ increased for for small incremental stick inputs

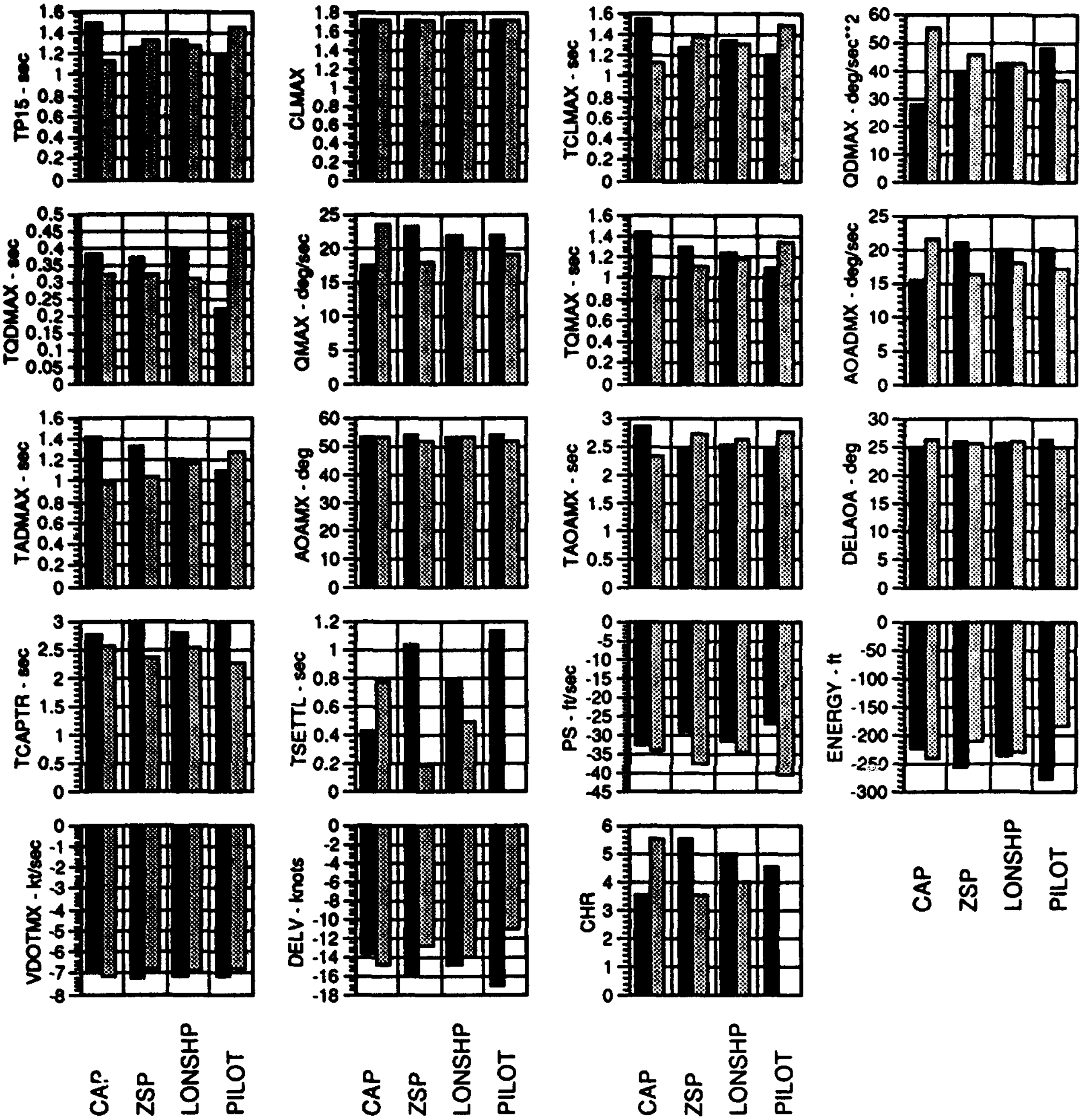
### Test Matrix

| Lon Config | Lat Config | CAP | ZSP | LONSHP |
|---|---|---|---|---|
| 108 | 2 | 0.28 (-) | 0.35/0.6 (-) | On (+) |
| 153 | 2 | 0.60 (+) | 0.35/0.6 (-) | Off (-) |
| 152 | 2 | 0.28 (-) | 0.70/1.2 (+) | Off (-) |
| 110 | 2 | 0.60 (+) | 0.70/1.2 (+) | On (+) |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ### | TP15 | 0.9999 | CAP | 1.000 | 1.4923 | 1.1258 | 0 | 0 | -0.286 | 1.27 | 2 | 2 | 3 |
| | | | ZSP | 1.000 | 1.2621 | 1.3278 | 0 | 0 | 0.051 | 0.23 | 4 | 3 | 4 |
| | | | LONSHP | 0.965 | 1.3186 | 1.2776 | 0 | 0 | -0.032 | 0.14 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 1.1609 | 1.4513 | 0 | 0 | 0.225 | | | | |
| 2 | CLMAX | 0.6697 | CAP | 0.888 | 1.719 | 1.7181 | 0 | 0 | -0.001 | 10.44 | 4 | 1 | 4 |
| | | | ZSP | 0.724 | 1.7183 | 1.7187 | 0 | 0 | 0.000 | 5.33 | 4 | 1 | 4 |
| | | | LONSHP | 0.666 | 1.7181 | 1.7188 | 0 | 0 | 0.000 | 6.89 | 4 | 1 | 4 |
| | | | PLT | 0.133 | 1.7185 | 1.7185 | 0 | 0 | 0.000 | | | | |
| 3 | TCLMAX | 0.9999 | CAP | 1.000 | 1.5423 | 1.1437 | 0 | 0 | -0.303 | 1.46 | 2 | 2 | 3 |
| | | | ZSP | 1.000 | 1.2775 | 1.3778 | 0 | 0 | 0.076 | 0.36 | 4 | 3 | 4 |
| | | | LONSHP | 0.971 | 1.3459 | 1.3143 | 0 | 0 | -0.024 | 0.11 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 1.2002 | 1.4763 | 0 | 0 | 0.209 | | | | |
| 6 | QDMAX | 0.9999 | CAP | 1.000 | 27.642 | 55.096 | 0 | 0 | 0.746 | 2.77 | 1 | 1 | 1 |
| | | | ZSP | 0.965 | 39.374 | 45.475 | 0 | 0 | 0.145 | 0.54 | 3 | 3 | 4 |
| | | | LONSHP | 0.567 | 42.138 | 42.635 | 0 | 0 | 0.012 | 0.04 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 47.554 | 36.441 | 0 | 0 | -0.269 | | | | |
| 7 | TQDMAX | 0.9999 | CAP | 0.977 | 0.3756 | 0.3187 | 0 | 0 | -0.165 | 0.18 | 3 | 3 | 4 |
| | | | ZSP | 0.955 | 0.3736 | 0.3162 | 0 | 0 | -0.168 | 0.18 | 3 | 3 | 4 |
| | | | LONSHP | 0.992 | 0.3868 | 0.3143 | 0 | 0 | -0.209 | 0.23 | 2 | 3 | 4 |
| | | | PLT | 1.000 | 0.218 | 0.493 | 0 | 0 | 0.909 | | | | |
| 8 | QMAX | 0.9999 | CAP | 1.000 | 17.528 | 23.381 | 0 | 0 | 0.292 | 2.13 | 2 | 1 | 2 |
| | | | ZSP | 1.000 | 23.276 | 18.083 | 0 | 0 | -0.255 | 1.86 | 2 | 2 | 3 |
| | | | LONSHP | 1.000 | 21.861 | 19.813 | 0 | 0 | -0.099 | 0.72 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 21.974 | 19.169 | 0 | 0 | -0.137 | | | | |
| 9 | TQMAX | 0.9999 | CAP | 1.000 | 1.4381 | 1.0044 | 0 | 0 | -0.367 | 1.77 | 2 | 2 | 3 |
| | | | ZSP | 1.000 | 1.2929 | 1.1162 | 0 | 0 | -0.147 | 0.71 | 3 | 3 | 4 |
| | | | LONSHP | 0.974 | 1.2413 | 1.1776 | 0 | 0 | -0.053 | 0.25 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 1.0895 | 1.3388 | 0 | 0 | 0.208 | | | | |
| 11 | AOADMX | 0.9999 | CAP | 1.000 | 15.469 | 21.452 | 0 | 0 | 0.333 | 2.01 | 2 | 1 | 2 |
| | | | ZSP | 1.000 | 21.129 | 16.252 | 0 | 0 | -0.265 | 1.60 | 2 | 2 | 3 |
| | | | LONSHP | 1.000 | 19.809 | 17.87 | 0 | 0 | -0.103 | 0.62 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 20.101 | 17.045 | 0 | 0 | -0.166 | | | | |
| 12 | TADMAX | 0.9999 | CAP | 1.000 | 1.4131 | 0.9758 | 0 | 0 | -0.379 | 2.33 | 2 | 1 | 2 |
| | | | ZSP | 1.000 | 1.3159 | 1.0393 | 0 | 0 | -0.238 | 1.47 | 2 | 2 | 3 |
| | | | LONSHP | 0.642 | 1.1959 | 1.1643 | 0 | 0 | -0.027 | 0.17 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 1.0895 | 1.2805 | 0 | 0 | 0.162 | | | | |
| 20 | AOAMX | 0.9999 | CAP | 0.079 | 52.928 | 52.958 | 0 | 0 | 0.001 | 0.02 | 4 | 3 | 4 |
| | | | ZSP | 1.000 | 53.913 | 51.974 | 0 | 0 | -0.037 | 1.01 | 4 | 2 | 4 |
| | | | LONSHP | 0.474 | 53.15 | 52.793 | 0 | 0 | -0.007 | 0.19 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 53.832 | 51.908 | 0 | 0 | -0.036 | | | | |
| 21 | TAOAMX | 0.9846 | CAP | 0.998 | 2.8714 | 2.3187 | 0 | 0 | -0.215 | 1.77 | 2 | 2 | 3 |
| | | | ZSP | 0.967 | 2.439 | 2.7086 | 0 | 0 | 0.105 | 0.86 | 3 | 3 | 4 |
| | | | LONSHP | 0.329 | 2.5141 | 2.6176 | 0 | 0 | 0.040 | 0.33 | 4 | 3 | 4 |
| | | | PLT | 0.916 | 2.4288 | 2.743 | 0 | 0 | 0.122 | | | | |
| 23 | DELAOA | 0.9908 | CAP | 0.997 | 25.029 | 26.368 | 0 | 0 | 0.052 | 0.99 | 4 | 3 | 4 |
| | | | ZSP | 0.756 | 25.879 | 25.621 | 0 | 0 | -0.010 | 0.19 | 4 | 3 | 4 |
| | | | LONSHP | 0.487 | 25.63 | 25.838 | 0 | 0 | 0.008 | 0.15 | 4 | 3 | 4 |
| | | | PLT | 0.994 | 26.372 | 25.024 | 0 | 0 | -0.052 | | | | |
| 25 | TCAPTR | 0.9954 | CAP | 0.561 | 2.7423 | 2.5544 | 0 | 0 | -0.071 | 0.25 | 4 | 3 | 4 |
| | | | ZSP | 0.964 | 2.9198 | 2.3624 | 0 | 0 | -0.213 | 0.74 | 2 | 3 | 4 |
| | | | LONSHP | 0.677 | 2.805 | 2.5209 | 0 | 0 | -0.107 | 0.37 | 4 | 3 | 4 |
| | | | PLT | 0.996 | 2.9823 | 2.243 | 0 | 0 | -0.289 | | | | |
| 26 | TSETTL | 0.9999 | CAP | 0.859 | 0.4167 | 0.7714 | 0 | 0 | 0.656 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.999 | 1.0346 | 0.1808 | 0 | 0 | -2.774 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.597 | 0.7682 | 0.49 | 0 | 0 | -0.465 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | 1.000 | 1.1286 | 0 | 0 | 0 | 0.000 | | | | |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 36 | PS | 0.9976 | CAP | 0.326 | -32.662 | -34.156 | 0 | 0 | -0.045 | 0.11 | 4 | 3 | 4 |
| | | | ZSP | 0.966 | -29.4 | -37.534 | 0 | 0 | -0.247 | 0.61 | 2 | 3 | 4 |
| | | | LONSHP | 0.522 | -31.631 | -34.813 | 0 | 0 | -0.096 | 0.24 | 4 | 3 | 4 |
| | | | PLT | 0.999 | -27.321 | -40.636 | 0 | 0 | -0.408 | | | | |
| 37 | ENERGY | 0.9997 | CAP | 0.717 | -223.75 | -242.71 | 0 | 0 | -0.081 | 0.19 | 4 | 3 | 4 |
| | | | ZSP | 0.991 | -257.17 | -210.75 | 0 | 0 | 0.200 | 0.47 | 2 | 3 | 4 |
| | | | LONSHP | 0.117 | -237.93 | -231.05 | 0 | 0 | 0.029 | 0.07 | 4 | 3 | 4 |
| | | | PLT | 1.000 | -277.33 | -183.37 | 0 | 0 | 0.426 | | | | |
| 38 | VDOTMX | 0.9999 | CAP | 0.991 | -6.8711 | -7.1089 | 0 | 0 | -0.034 | 0.63 | 4 | 3 | 4 |
| | | | ZSP | 1.000 | -7.1937 | -6.8046 | 0 | 0 | 0.056 | 1.03 | 4 | 2 | 4 |
| | | | LONSHP | 0.891 | -7.1006 | -6.9248 | 0 | 0 | 0.025 | 0.46 | 4 | 3 | 4 |
| | | | PLT | 1.000 | -7.1732 | -6.7962 | 0 | 0 | 0.054 | | | | |
| 39 | DELV | 0.9998 | CAP | 0.701 | -13.717 | -14.88 | 0 | 0 | -0.081 | 0.18 | 4 | 3 | 4 |
| | | | ZSP | 0.990 | -15.782 | -12.905 | 0 | 0 | 0.203 | 0.46 | 2 | 3 | 4 |
| | | | LONSHP | 0.370 | -14.806 | -14.004 | 0 | 0 | 0.056 | 0.13 | 4 | 3 | 4 |
| | | | PLT | 1.000 | -17.094 | -11.134 | 0 | 0 | 0.442 | | | | |
| 49 | CHR | 0 | CAP | -999.000 | 3.5 | 5.5 | 0 | 0 | 0.468 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | ZSP | -999.000 | 5.5 | 3.5 | 0 | 0 | -0.468 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LONSHP | -999.000 | 5 | 4 | 0 | 0 | -0.225 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 4.5 | | 0 | 0 | 0.000 | | | | |

STEM 7 TEST 2



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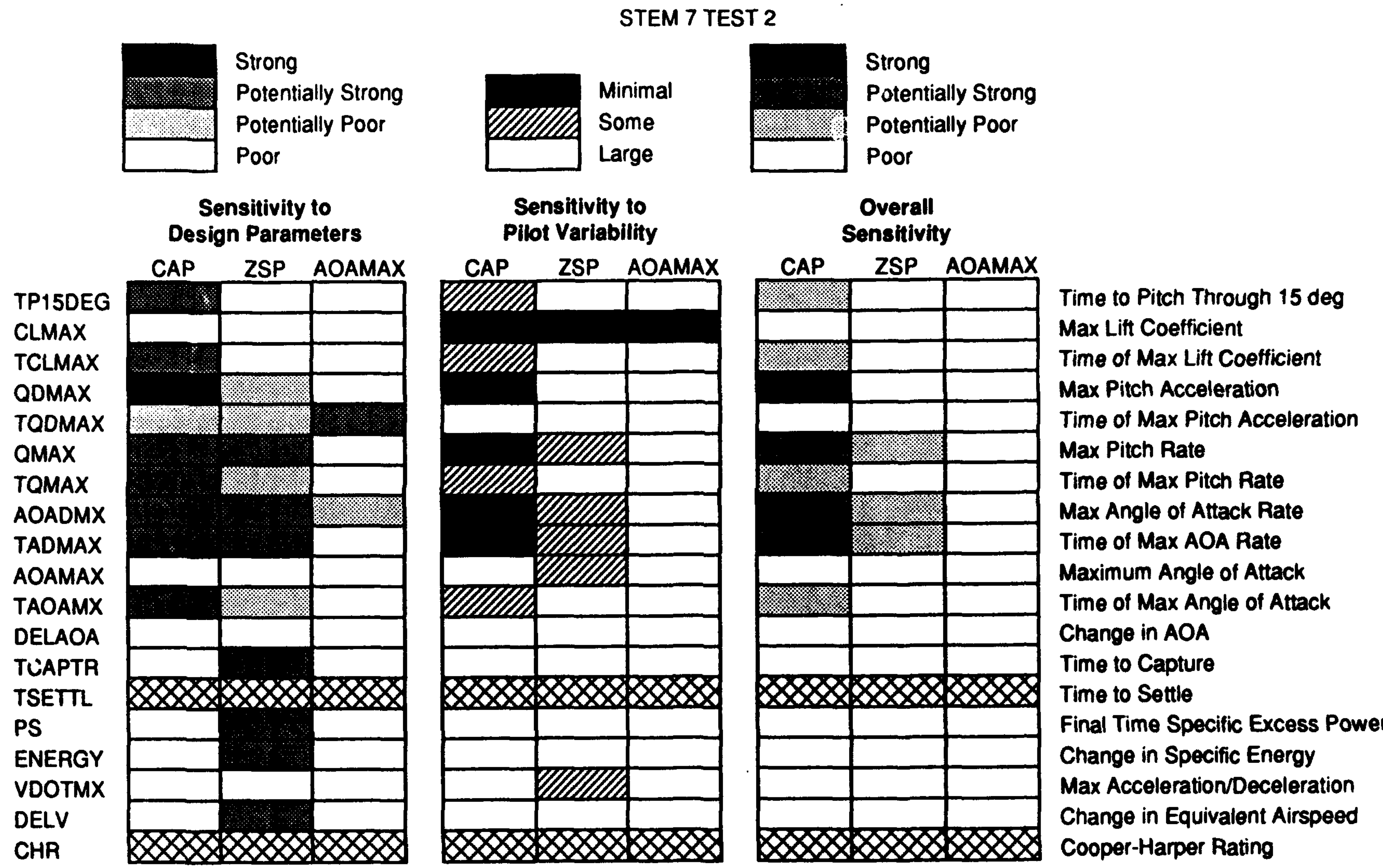
CLMAX
TCLMAX - sec
QDMAX - deg/sec**2
TQDMAX - sec
QMAX - deg/sec
TQMAX - sec
AOADMX - deg/sec
TADMAX - sec
AOAMX - deg
TAOAMX - sec
DELAOA - deg
TCAPTR - sec
TSETTL - sec
PS - ft/sec
ENERGY - ft
VDOTMX - kt/sec
DELV - knots
CHR
CAP
ZSP
LONSHP
PILOT


STEM 7 TEST 2
Strong
Potentially Strong
Potentially Poor
Poor
Minimal
Some
Large
Strong
Potentially Strong
Potentially Poor
Poor
Sensitivity to Design Parameters
Sensitivity to Pilot Variability
Overall Sensitivity
CAP
ZSP
AOAMAX
CAP
ZSP
AOAMAX
CAP
ZSP
AOAMAX
TP15DEG
CLMAX
TCLMAX
QDMAX
TQDMAX
QMAX
TQMAX
AOADMX
TADMAX
AOAMAX
TAOAMX
DELAOA
TCAPTR
TSETTL
PS
ENERGY
VDOTMX
DELV
CHR
Time to Pitch Through 15 deg
Max Lift Coefficient
Time of Max Lift Coefficient
Max Pitch Acceleration
Time of Max Pitch Acceleration
Max Pitch Rate
Time of Max Pitch Rate
Max Angle of Attack Rate
Time of Max AOA Rate
Maximum Angle of Attack
Time of Max Angle of Attack
Change in AOA
Time to Capture
Time to Settle
Final Time Specific Excess Power
Change in Specific Energy
Max Acceleration/Deceleration
Change in Equivalent Airspeed
Cooper-Harper Rating

STEM 7 TEST 2
PILOT A
LONGITUDINAL CONFIGURATION 108
LATERAL CONFIGURATION 2
CHR 4

I'm putting in full aft stick and checking forward to stop. I'm maintaining a moderate amount of aft stick force in order to hold on the target. I'll try to be a little more gradual in my release and see how that works. I'm happy with what I think is the optimum technique. That time I tried to ease off of the stick, coming about 3/4 of the way uphill. It works all right if you can learn to do it that way. I don't think it affects my time much. I think bang bang is probably faster though. I'm just being as aggressive as I can and still trying to maintain my desired criteria. The technique I'm using is: immediate slam to full aft stick, watching the target, not the pitch ladder, when the target is approaching my desired criteria I'm releasing stick beyond the neutral position and as my rate starts to slow I'm bringing the stick back to a medium aft position with reasonable aft stick force in order to hold the new increased angle of attack and therefore new increased aft stick forces. Selecting Cooper Harper -.Is it controllable? Yes. It is always controllable throughout the whole thing - no problem. Is adequate performance attainable with tolerable workload? Yes. You can obtain adequate performance. The most overshoots I ever saw were 2 and that was where I didn't compensate properly. If I get the proper compensation then its easy to make adequate performance. Is it satisfactory without improvement? Deficiencies warrant improvement? I would say no, it is not satisfactory without improvement. It requires moderate pilot compensation. There are minor but annoying deficiencies and it requires moderate compensation in that I have to be kind of a lead filter. If I was smoother and slower on this thing then it would be okay, but I'm attempting to get there in absolute minimum time so I'm using full aft stick to get the max rate I can, and then rather than slowly bleed off that pitch rate to hit my target, I am attempting to use an abrupt forward command to stop my pitch rate and again get on the aft stick to sustain that pitch, and therefore it requires a little bit of a learning curve. So desired performance requires moderate pilot compensation. It is difficult to predict how much aft stick force is going to be needed to hold the angle of attack and therefore there is a lot of tendency to drop off of the target because its hard to anticipate how much aft stick force to maintain. Thats where a lot of the compensation comes in, learning how much aft stick force to hold my nose at that condition. So if you ended up with more of a rate command system once you got to your angle of attack or something like that then it would be a lot easier once you got up there to stabilize on the thing - that would have reduced the pilot workload. I don't know if rate command is the right suggestion but some more predictable stick position or stick force so that I didn't have to become such an important part of the process to be able to hold that specific pitch position, to be able to track them.

STEM 7 TEST 2
PILOT E
LONGITUDINAL CONFIGURATION 108
LATERAL CONFIGURATION 2

This one seems to have a real nice final pitch rate, but it's a little slower building up and then it's real difficult to stop. It takes a whole lot of back stick to hold it. What I'm having to do is not use full back

stick so the rate doesn't build up so badly, because it's real difficult to stop at a high rate. So that's going to leave you pretty low initial pitch rate. The pitch rate is adequate. It seems to be a little slower building up than some of them, but the final rate is real good, probably too high to control, kind of like some of the quicker ones.

STEM 7 TEST 2
PILOT A
LONGITUDINAL CONFIGURATION 153
LATERAL CONFIGURATION 2
CHR 7
PIO 3

This airplane feels springier - the nose bounces around a little more. Precise alpha control is harder, even just setting up. That has a PIO tendency all right. The initial acceleration is great, the pitch rate is great but the predictability of the pitch attitude capture is lousy. It almost makes it unattainable here. Yeah I'm just barely making adequate criteria. You have to be very smooth and steady with the stick. You can't give a bang bang control with the stick, otherwise it generates a pitch bobble beyond the constaints of the test. It is an unpredictable configuration. It makes it difficult to do a minimum time task because you're trying to be quick and authoritative on the controls and its not letting me. The technique that I'm doing is a full aft stick input and then as I'm approaching the target I'm trying to smoothly release the stick and minimize my final pitch corrections and slowly ease to the aft stick position necessary to hold the pitch attitude. I have to try and keep my final corrections to a minimum because they cause an overshoot beyond the bounds of my desired criteria. I'm ending up in a PIO, everything's good except for the PIO tendency, which is driving me beyond my desired criteria and occasionally beyond my adequate criteria. Cooper Harper. It is controllable. Is adequate performance attaintable with a tolerable workload? I would say no. My adequate criteria was that I could sustain the capture with only 2 overshoots. I could do it sometimes, but I could not guarantee that I could maintain adequate performance. Therefore it was not a tolerable pilot workload, it was the limit of my ability to attain adequate performance and thats with a bunch of practice runs so therefore deficiencies require improvement. Generally adequate performance was not attainable with all my tolerable compensation. That was all I was doing with the aircraft and I could not consistently keep from getting more than 2 overshoots. We definitely had PIO trouble so I'll select PIO rating. I can't eliminate the PIO completely - I can keep the PIO within the tolerances of my test maneuver. Undesirable motions easily induced while pilot initiates abrupt maneuevers or attempts tight control. These can be prevented or eliminated only at sacrifice to task performance or through considerable pilot attention and effort. That is the level of PIO we are at here. That is correct. It is not any sort of safety of flight thing - it is just that it takes considerable pilot attention and effort to keep the PIOs down.

STEM 7 TEST 2
PILOT E
LONGITUDINAL CONFIGURATION 153
LATERAL CONFIGURATION 2

This one has got a much faster initial pitch rate and it's more difficult to capture. Yeah that is tough. It still takes a lot of back pressure to hold it here. I find it's easier not to go full back stick on this one. About half back stick and then relax the back pressure to stop it and then put the back pressure back in to hold the capture. It takes significant back pressure to hold it up there just like the others did and not much to stop it. Even with half back stick it's a little bit difficult to stop. You have to be pretty quick to stop it and then maintain it in the capture zone. Yeah, it's really difficult to capture it within those limits. Quick to get there and slow to capture.

STEM 7 TEST 2
PILOT A
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 2
CHR 3
PIO 2

It is sluggish coming up hill, looks like its going to be pretty easy to track though. Initial acceleration is good, final rate is too low. That makes the final handling quality of the capture easier because the rates are lower, but it degrades the overall mission. The capture and hold for one second is fairly easily attainable. Only requires minimal compensation. The technique I'm using again is slam to full aft stick, wait, and with this one it happens so slowly I could wait until I'm almost at the target before I release the aft stick, and then I can just sort of release aft stick and then reset the aft stick to hold the pitch attitude and it stops pretty nicely. Its predictable, not much tendency to PIO. It gives me about a half or 3/4 of a degree pitch bobble and thats all. I had a PIO plus or minus 1/2 degree that is purely caused by the unpredictability of the amount of aft stick required to maintain the new angle of attack. The actual capture is well within desired tolerance and pretty easy to maintain. In order to get a square input on these things I'm using 2 hands to pull the stick aft. Which is not an uncommon thing to do. Cooper Harper. Is it controllable? Yes, its easily controllable. Is adequate performance attainable with a tolerable pilot workload? Yes, I could easily hit my adequate criteria. Now all of this is caveated with the fact that the pitch rate, the final pitch rate is slow. Pitch acceleration is good, but the pitch rate is too slow. Satisfactory without improvement? Using just our criteria of the pitch capture, yes, it is satisfactory without improvement. I could easily get inside my tolerances. Minimal pilot compensation required for desired performance. What I'm having to do is, when I get there I just time it right, I release the stick and then I smoothly apply back stick, I stabilize, I got repeatable plus or minus a maximum of 1 degree, more likely 1/2 degree so that gives me some mildly unpleasant deficiencies. It is fair. If it was excellent I could get up there, set the stick predictably every time and I would not have these little oscillations. There is some tendency for undesirable motions. They tend to occur when pilot initiates abrupt maneuevers or attempts tight control - these motions can be prevented or eliminated by pilot technique. This one had an undesirable amount of time to target. I'm just using the Cooper Harper purely on the capture task and not the pitch rate.

STEM 7 TEST 2
PILOT E
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 2

Slower on the pitch onset and squirrellier there as far as trying to capture too. I seem to have to be more aggressive stopping this one than we did the last one (longitudinal configuration 103). It still requires significant back pressure to hold it at this angle of attack. Full aft stick, relax and then maximum back pressure. This one seems to be a little slower on the pitch onset and a little more difficult to capture. Actually, the capture is not much different, but the onset rate is significantly lower. You don't actually have to react to try to stop it here until it gets within about 2-1/2 degrees of the target and then I can just relax the back pressure and it stops pretty quickly, so pretty good capture dynamics, just a little slow on the pitch start.

STEM 7 TEST 2
PILOT A
LONGITUDINAL CONFIGURATION 110
LATERAL CONFIGURATION 2
CHR 4
PIO 2

Pitch predictability is slightly lower this time but not bad. Bobbling just a hair. Good pitch rate. Pitch stop at the top is very abrupt. I've got to be ready for that. Lots of stabilator authority up there. The onset rate of acceleration is very quick, the final rate is good, nice pitch response and a very quick recovery from it. I had a 3 oscillation PIO but it was all within my desired criteria tolerances. It is caused by a slight lack of predictability of just how abrupt the airplane is. If I just neutralize stick, the rate stops and then I can just slowly feed in my aft stick to hold the attitude without generating any new rate. Its a little bit unnatural to arrest the rate just by releasing stick. Normally you need to put in some counter command to make things stop. The way I am doing this is to use full aft stick, until I'm basically on the pitch attitude that I want and then I just release the stick to neutral and smoothly feed in aft stick. I have a basic dislike of these stick dynamics required to make it stop up there. Cooper-Harper: Is it controllable? Yes. Is adequate performance attainable with a tolerable pilot workload? Yes. The most I ever had was 1 overshoot. I'm having an overshoot 1/2 the time. Is it satisfactory without improvement? No. Deficiencies warrant improvement. I can make desired performance but I have to work somewhere between moderate and pretty hard. If I work hard at it, if I apply the right technique I can keep it inside. It got outside a couple of times because I didn't apply quite enough pilot compensation so there are minor but annoying deficiencies. I am not particuarly happy with this mechanization but that could be my background. I'm not used to having a rate command system at high angle of attack. I'm contradicting myself saying maybe I would have liked it but now that I've tried it I find it kind of unnatural just to release stick, especially when normally you have to sustain an aft stick force just to hold that flight condition. It would seem more natural to have to push the stick forward in order to arrest the rate and to just neutralize the stick. There are oscillations, undesirable motions. I always had a little bit of an PIO. I would have had to work very hard to completely eliminate the PIO but the PIO was within my desired tolerances and it never really got close to bouncing me outside.

STEM 7 TEST 2
PILOT E
LONGITUDINAL CONFIGURATION 110
LATERAL CONFIGURATION 2

It's a little hard to capture at this alpha. I tend to over compensate on stopping it. It takes significant back stick at this alpha just to hold it here, so you just have to relax pressure. It has a pretty good initial pitch onset and all you have to do to stop it is to relax a little bit of the back pressure because a significant amount of back pressure required just to hold it at this angle of attack. So you don't really have to stop it, you just kind of relax the back pressure. Good dynamics--no problem. No complaints. It's easy to capture once you figure it out. The tendency is to relax too much back pressure and undershoot the capture.

STEM 7 TEST 2 (Without target)
PILOT E
LONGITUDINAL CONFIGURATION 153
LATERAL CONFIGURATION 2

Real good initial pitch acceleration and a good pitch rate. I can't use it all. I'm having to use partial back stick. I am using the ADI to get it up between 50 and 60 degrees and then fine-tuning it on the HUD. It requires a lot of back stick to hold the pipper on it at high angle attack and its pretty squirrely up there, difficult to hold it within the tolerances. The tendency is to relax too much back stick while stopping it. You have to kind of nurse it up there using about 1/2 stick or so, so that the rate doesn't build up so badly, and its a little difficult to stop because you have to just barely relax the back pressure to stop it. Then you have to put a lot of the back pressure back in to hold it at the angle of attack so its a little difficult to track it. Good initial acceleration.

STEM 7 TEST 2 (Without target)
PILOT E
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 2

This one has much slower initial acceleration. I can use all the pitch rate on this one. And it takes just about full back stick to hold it up. Stick forces are much higher, seem to be higher on this one. It has a fairly slow initial pitch acceleration, and builds up to a fairly good rate in the end. It is moderately difficult to track because you have to hold so much back pressure. Still looks like slow initial pitch acceleration, fairly decent final rate. It is a little difficult to capture because of the heavy back pressure that you need to hold it.

## Summary of Design Parameters Tested for STEM 7 TEST 3

Test variables:

ZW: Not varied. Indicates $\zeta * \omega$ (inverse of the pitch rate time constant) $\zeta * \omega$ scheduled linearly with knots equivalent airspeed (KEAS) with the following value at 100 KEAS:
2.0 $sec^{-1}$, ($\tau$=0.5 sec)

TV: Controls whether or not pitch thrust vectoring was enabled:
(-) No vectoring, results in the pitch rate system being AOA limited
(+) With vectoring

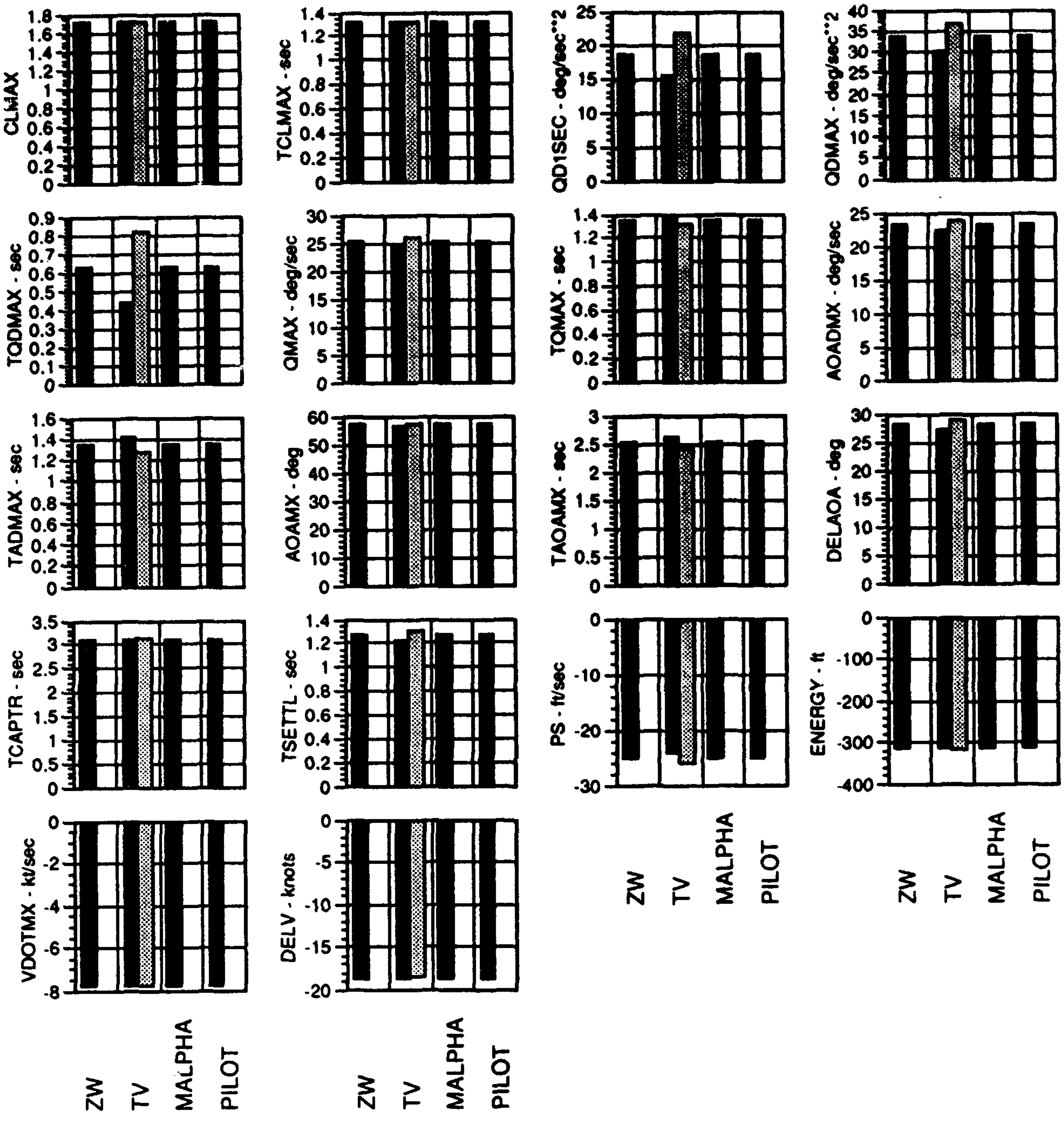
MALPHA: Not varied. Indicates the longitudinal stability of the aircraft:
-0.5 $sec^{-2}$, Stable

### Test Matrix

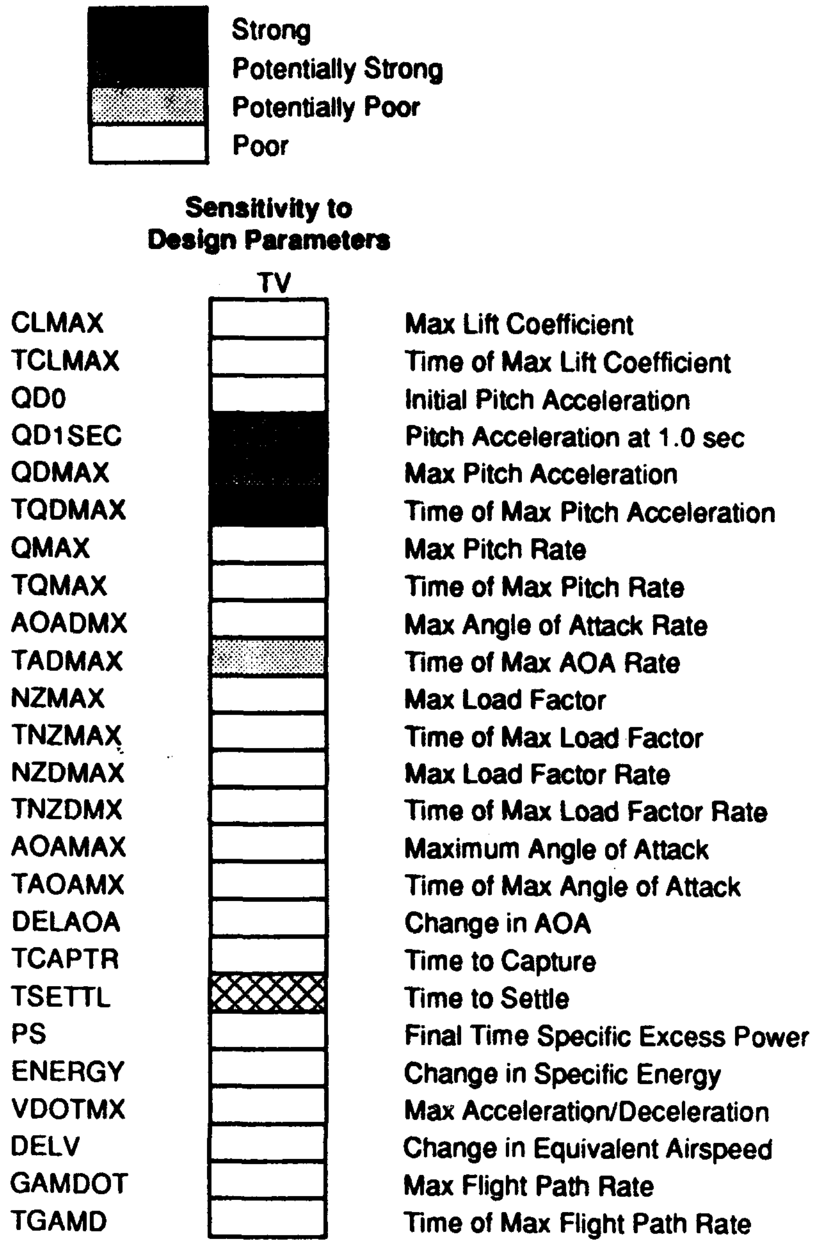
| Lon Config | Lat Config | ZW | TV | MALPHA |
|---|---|---|---|---|
| 107 | 2 | 2.0 | On (+) | -0.5 |
| 157 | 2 | 2.0 | Off (-) | -0.5 |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | CLMAX | 0.3179 | TV | 0.318 | 1.7195 | 1.7187 | 0 | 0 | 0.000 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 1.7191 | | 0 | 0 | 0.000 | | | | |
| 3 | TCLMAX | 0.5856 | TV | 0.586 | 1.3071 | 1.3224 | 0 | 0 | 0.012 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 1.3147 | | 0 | 0 | 0.000 | | | | |
| ### | QD0 | 0.4672 | TV | 0.467 | 1.6063 | 1.1335 | 0 | 0 | -0.356 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 1.3699 | | 0 | 0 | 0.000 | | | | |
| ### | QD1SEC | 0.99 | TV | 0.990 | 15.466 | 21.792 | 0 | 0 | 0.350 | #DIV/0! | 2 | ##### | ##### |
| | | | PLT | -999.000 | 18.629 | | 0 | 0 | 0.000 | | | | |
| 6 | QDMAX | 0.9999 | TV | 1.000 | 30.113 | 36.754 | 0 | 0 | 0.201 | #DIV/0! | 2 | ##### | ##### |
| | | | PLT | -999.000 | 33.434 | | 0 | 0 | 0.000 | | | | |
| 7 | TQDMAX | 0.9999 | TV | 1.000 | 0.4404 | 0.8224 | 0 | 0 | 0.666 | #DIV/0! | 1 | ##### | ##### |
| | | | PLT | -999.000 | 0.6314 | | 0 | 0 | 0.000 | | | | |
| 8 | QMAX | 0.9999 | TV | 1.000 | 24.506 | 25.758 | 0 | 0 | 0.050 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 25.132 | | 0 | 0 | 0.000 | | | | |
| 9 | TQMAX | 0.9366 | TV | 0.937 | 1.3737 | 1.3057 | 0 | 0 | -0.051 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 1.3397 | | 0 | 0 | 0.000 | | | | |
| 11 | AOADMX | 0.9996 | TV | 1.000 | 22.453 | 23.777 | 0 | 0 | 0.057 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 23.115 | | 0 | 0 | 0.000 | | | | |
| 12 | TADMAX | 0.9987 | TV | 0.999 | 1.4071 | 1.2724 | 0 | 0 | -0.101 | #DIV/0! | 3 | ##### | ##### |
| | | | PLT | -999.000 | 1.3397 | | 0 | 0 | 0.000 | | | | |
| 14 | NZMAX | 0.7217 | TV | 0.722 | 1.1659 | 1.1469 | 0 | 0 | -0.016 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 1.1564 | | 0 | 0 | 0.000 | | | | |
| 15 | TNZMAX | 0.7343 | TV | 0.734 | 1.4071 | 1.439 | 0 | 0 | 0.022 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 1.4231 | | [illegible] | 0 | 0.000 | | | | |
| 16 | NZDMAX | 0.3188 | TV | 0.319 | 0.2724 | 0.2776 | 0 | 0 | 0.019 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 0.275 | | 0 | 0 | 0.000 | | | | |
| 17 | TNZDMX | 0.9705 | TV | 0.971 | 0.8[illegible] | 0.939 | 0 | 0 | 0.091 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 0.898 | | 0 | 0 | 0.000 | | | | |
| 20 | AOAMX | 0.4731 | TV | 0.473 | [illegible].671 | 57.297 | 0 | 0 | 0.011 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 56.984 | | 0 | 0 | 0.000 | | | | |
| 21 | TAOAMX | 0.9935 | TV | 0.994 | 2.6071 | 2.4057 | 0 | 0 | -0.080 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 2.5064 | | 0 | 0 | 0.000 | | | | |
| 23 | DELAOA | 0.7945 | TV | 0.795 | 27.359 | 28.869 | 0 | 0 | 0.054 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 28.114 | | 0 | 0 | 0.000 | | | | |
| 25 | TCAPTR | 0.0385 | TV | 0.039 | 3.1071 | 3.1224 | 0 | 0 | 0.005 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 3.1147 | | 0 | 0 | 0.000 | | | | |
| 26 | TSETTL | 0.1604 | TV | 0.160 | 1.2333 | 1.3 | 0 | 0 | 0.053 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 1.2667 | | 0 | 0 | 0.000 | | | | |
| 36 | PS | 0.2486 | TV | 0.249 | -24.26 | -26.03 | 0 | 0 | -0.070 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | -25.14 | | 0 | 0 | 0.000 | | | | |
| 37 | ENERGY | 0.1347 | TV | 0.135 | -312.5 | -316.9 | 0 | 0 | -0.014 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | -314.7 | | 0 | 0 | 0.000 | | | | |
| 38 | VDOTMX | 0.1717 | TV | 0.172 | -7.728 | -7.782 | 0 | 0 | -0.007 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | -7.755 | | 0 | 0 | 0.000 | | | | |
| 39 | DELV | 0.0651 | TV | 0.065 | -18.72 | -18.58 | 0 | 0 | 0.007 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | -18.65 | | 0 | 0 | 0.000 | | | | |
| 40 | GAMDOT | 0.4812 | TV | 0.481 | 2.0548 | 1.9451 | 0 | 0 | -0.055 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 2 | | 0 | 0 | 0.000 | | | | |
| 41 | TGAMD | 0.7343 | TV | 0.734 | 1.3071 | 1.339 | 0 | 0 | 0.024 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 1.3231 | | 0 | 0 | 0.000 | | | | |

STEM 7 TEST 3


CLMAX
TCLMAX - sec
QD1SEC - deg/sec**2
QDMAX - deg/sec**2
TQDMAX - sec
QMAX - deg/sec
TQMAX - sec
AOADMX - deg/sec
TADMAX - sec
AOAMX - deg
TAOAMX - sec
DELAOA - deg
TCAPTR - sec
TSETTL - sec
PS - ft/sec
ENERGY - ft
VDOTMX - kt/sec
DELV - knots
ZW
TV
MALPHA
PILOT

STEM 7 TEST 3




Note: Data available for only a single pilot,
therefore, sensitivity to pilot variability and overall sensitivity not shown.

STEM 7 TEST 3
PILOT A
LONGITUDINAL CONFIGURATION 107
LATERAL CONFIGURATION 2

Initial acceleration is too slow, but then it ramps up to a very fast rate. Its requiring no aft stick to hold me at 55. Thats unusual. What I'm trying to do is to neutralize stick since it doesn't take any aft stick force. It makes it kind of a different way to do this task. I suppose I could learn to like that because I put my nose where I want it and it stays there. I don't have to fight it, but it gives very little feedback back to the pilot of a very high energy bleeding condition. It would be easy to run out of airspeed heading up hill. I find it a little bit unpredictable to quickly capture it. I have to use very low gain inputs as I capture it, otherwise I overshoot it in a PIO. Its hard to figure out how much to lead the pitch capture by. I'm tending to stabilize outside of desired and then make one correction to get back inside my band because of a bad guess. When I try to be more aggressive I overshoot it beyond my adequate criteria. I start springing up and down. But of course once I get there I just let go of the stick and it sits there like a rock. I still haven't learned after 6 tries because its a foreign feeling system to me. Try again. Finally got it and then I bounced out of it because I tried to put in aft stick. Thats a bit of negative training in that for every single other configuration I've done its required some aft stick to hold it up there. I've got to remember not to apply aft stick once I get it inside my tolerances. Finally starting to learn how much to lead it by. It works better if I just time it exactly right and get the stick to neutral so that it stops where I want. If I don't choose that exact moment correctly, then the corrections are difficult. Overall I don't like this, I only have 1 quick shot at stabilizing it inside the desired criteria. If I don't hit it then I have to stop at the wrong pitch attitude - wait a second and then slowly correct back inside my desired criteria.

STEM 7 TEST 3
PILOT A
LONGITUDINAL CONFIGURATION 157
LATERAL CONFIGURATION 2

Again its requiring no stick to stay there. I have to lead my pitch capture by about 15 degrees with forward stick. I'm hitting the forward stop in order to try to minimize the time. We're back to a bang bang system. When I'm doing a maximum rate task, going to full aft to get the rate and full forward to stop the rate seems like the natural thing to do. It is what a Piper Cub does. I guess theres a little bit too much pitch inertia. In order to stop my rate, I'm forced to put the stick in earlier than I want. I have to get rid of my max rate early. I would be happier if forward stick would stop the pitch rate quicker. Its slightly too sluggish for pitch arrestment. I don't get to stay at my max pitch rate long enough. If that was a bogie turning to shoot me, it is unnatural for me to be full aft stick and have to go full forward stick 15 to 20 degrees before I get there in order to stop my nose on the target. It is undesirable to have to lead the capture by so much. And then the following handling qualities are kind of bizarre where it is hands off up until the point where it just kind of falls off on its own with no warning. It would be terribly difficult to track anybody in a nose pointing situation, if thats the kind of handling qualities you had because suddenly the nose would start to fall off and its not related to your stick position.

## Summary of Design Parameters Tested for STEM 7 TEST 4

Test variables:

ZW: Indicates $\zeta^*\omega$ (inverse of the pitch rate time constant) $\zeta^*\omega$ not scheduled with airspeed, held constant at the following values:

(+) 4.0 $sec^{-1}$, ($\tau$=0.25 sec)
(-) 1.0 $sec^{-1}$, ($\tau$=1.0 sec)

TV: Not varied. Thrust vectoring was enabled.

MALPHA: Not varied. Indicates the longitudinal stability of the aircraft:
-0.5 $sec^{-2}$, Stable

### Test Matrix

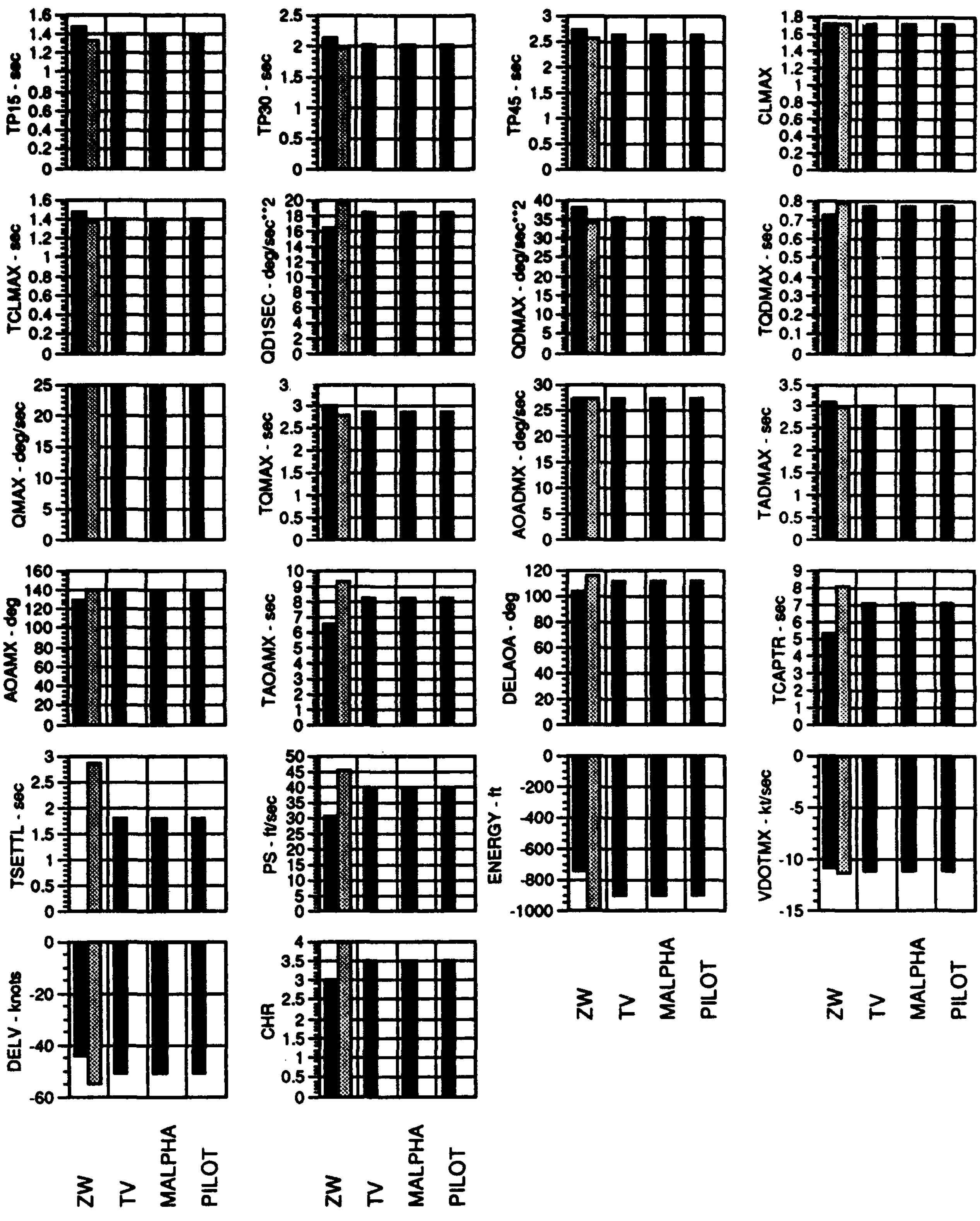
| Lon Config | Lat Config | ZW | TV | MALPHA |
|---|---|---|---|---|
| 129 | 2 | 4.0 (+) | On | -0.5 |
| 130 | 2 | 1.0 (-) | On | -0.5 |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ### | TP15 | 0.9999 | ZW | 1.000 | 1.4725 | 1.3323 | 0 | 0 | -0.100 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 1.3849 | | 0 | 0 | 0.000 | | | | |
| ### | TP30 | 0.9999 | ZW | 1.000 | 2.1283 | 1.952 | 0 | 0 | -0.087 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 2.0181 | | 0 | 0 | 0.000 | | | | |
| ### | TP45 | 0.9998 | ZW | 1.000 | 2.7185 | 2.5519 | 0 | 0 | -0.063 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 2.6144 | | 0 | 0 | 0.000 | | | | |
| 2 | CLMAX | 0.9766 | ZW | 0.977 | 1.7199 | 1.7176 | 0 | 0 | -0.001 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 1.7184 | | 0 | 0 | 0.000 | | | | |
| 3 | TCLMAX | 0.9926 | ZW | 0.993 | 1.4726 | 1.3618 | 0 | 0 | -0.078 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 1.4033 | | 0 | 0 | 0.000 | | | | |
| ### | QD0 | 0.9933 | ZW | 0.993 | -0.1082 | 1.4973 | 0 | 0 | 7.955 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 0.8952 | | 0 | 0 | 0.000 | | | | |
| ### | QD1SEC | 0.9473 | ZW | 0.947 | 16.393 | 19.421 | 0 | 0 | 0.170 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 18.285 | | 0 | 0 | 0.000 | | | | |
| 6 | QDMAX | 0.8596 | ZW | 0.860 | 38.075 | 33.837 | 0 | 0 | -0.118 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 35.426 | | 0 | 0 | 0.000 | | | | |
| 7 | TQDMAX | 0.9142 | ZW | 0.914 | 0.7348 | 0.7913 | 0 | 0 | 0.074 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 0.7701 | | 0 | 0 | 0.000 | | | | |
| 8 | QMAX | 0.9999 | ZW | 1.000 | 24.863 | 24.999 | 0 | 0 | 0.005 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 24.948 | | 0 | 0 | 0.000 | | | | |
| 9 | TQMAX | 0.9981 | ZW | 0.998 | 3.0135 | 2.7782 | 0 | 0 | -0.081 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 2.8664 | | 0 | 0 | 0.000 | | | | |
| 11 | AOADMX | 0.792 | ZW | 0.792 | 27.16 | 27.128 | 0 | 0 | -0.001 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 27.14 | | 0 | 0 | 0.000 | | | | |
| 12 | TADMAX | 0.9989 | ZW | 0.999 | 3.1119 | 2.9651 | 0 | 0 | -0.048 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 3.0201 | | 0 | 0 | 0.000 | | | | |
| 14 | NZMAX | 0.9977 | ZW | 0.998 | 1.1384 | 1.1661 | 0 | 0 | 0.024 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 1.1557 | | 0 | 0 | 0.000 | | | | |
| 15 | TNZMAX | 0.9851 | ZW | 0.985 | 1.5873 | 1.4897 | 0 | 0 | -0.064 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 1.5263 | | 0 | 0 | 0.000 | | | | |
| 16 | NZDMAX | 0.1318 | ZW | 0.132 | -0.104 | -0.0715 | 0 | 0 | 0.384 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | -0.0837 | | 0 | 0 | 0.000 | | | | |
| 17 | TNZDMX | 0.0378 | ZW | 0.038 | 2.8168 | 2.7683 | 0 | 0 | -0.017 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 2.7865 | | 0 | 0 | 0.000 | | | | |
| 20 | AOAMX | 0.9823 | ZW | 0.982 | 129.23 | 140.42 | 0 | 0 | 0.083 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 136.22 | | 0 | 0 | 0.000 | | | | |
| 21 | TAOAMX | 0.9903 | ZW | 0.990 | 6.4726 | 9.2503 | 0 | 0 | 0.365 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 8.2086 | | 0 | 0 | 0.000 | | | | |
| 23 | DELAOA | 0.9883 | ZW | 0.988 | 103.47 | 115.65 | 0 | 0 | 0.112 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 111.08 | | 0 | 0 | 0.000 | | | | |
| 25 | TCAPTR | 0.9899 | ZW | 0.990 | 5.3086 | 8.07 | 0 | 0 | 0.431 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 7.0345 | | 0 | 0 | 0.000 | | | | |
| 26 | TSETTL | 0.9915 | ZW | 0.992 | 0 | 2.8427 | 0 | 0 | 0.000 | #NUM! | 4 | #NUM! | #NUM! |
| | | | PLT | -999.000 | 1.7767 | | 0 | 0 | 0.000 | | | | |
| 36 | PS | 0.9934 | ZW | 0.993 | 30.228 | 45.071 | 0 | 0 | 0.410 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 39.505 | | 0 | 0 | 0.000 | | | | |
| 37 | ENERGY | 0.9953 | ZW | 0.995 | -746.77 | -996.16 | 0 | 0 | -0.292 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | -902.64 | | 0 | 0 | 0.000 | | | | |
| 38 | VDOTMX | 0.9999 | ZW | 1.000 | -10.876 | -11.358 | 0 | 0 | -0.043 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | -11.178 | | 0 | 0 | 0.000 | | | | |
| 39 | DELV | 0.9984 | ZW | 0.998 | -44.249 | -55.066 | 0 | 0 | -0.220 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | -51.01 | | 0 | 0 | 0.000 | | | | |
| 40 | GAMDOT | 0.9664 | ZW | 0.966 | -3.8751 | -4.6426 | 0 | 0 | -0.182 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | -4.3548 | | 0 | 0 | 0.000 | | | | |

STEM 7 TEST 4

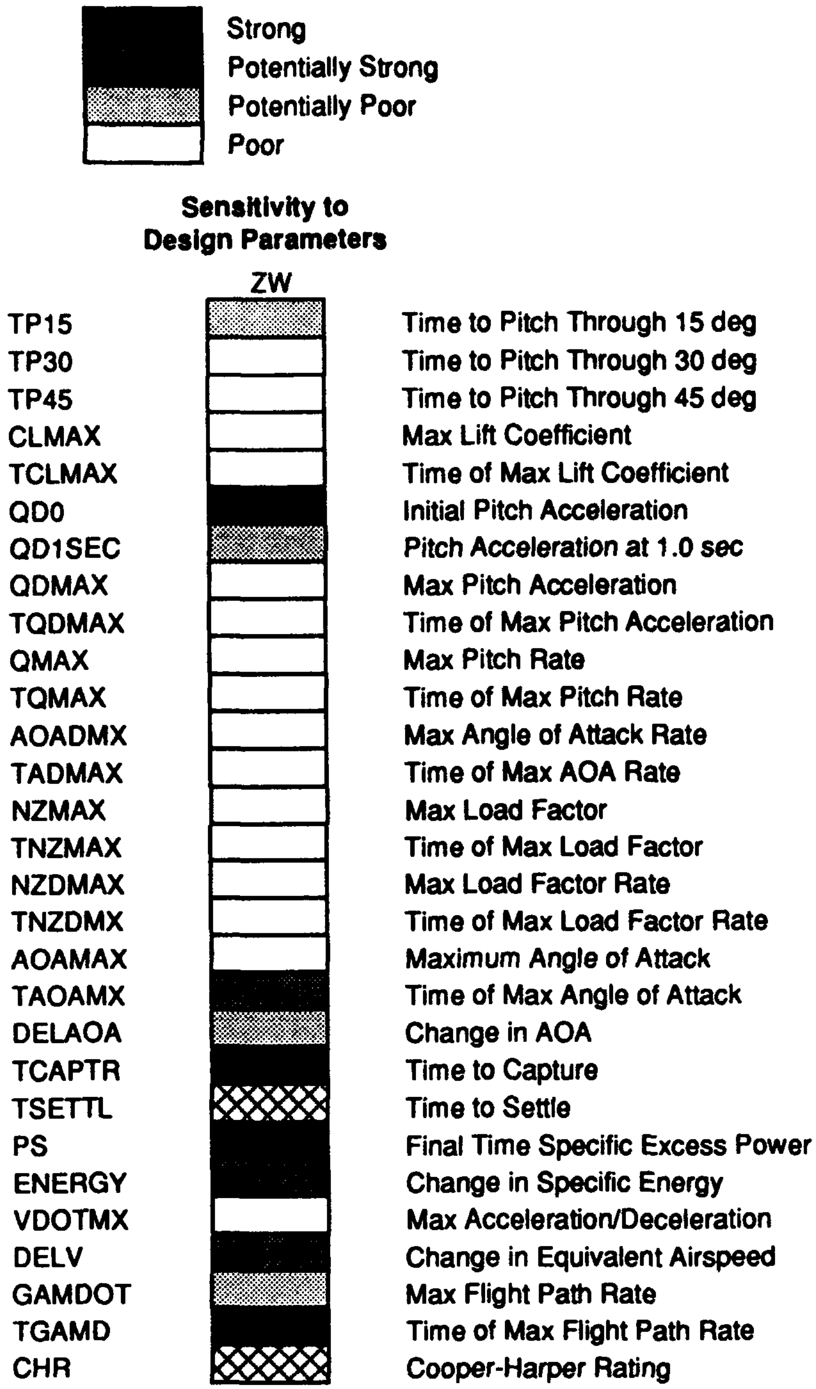
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 41 | TGAMD | 0.9815 | ZW | 0.982 | 3.5545 | 7.47 | 0 | 0 | 0.813 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 6.0017 | | 0 | 0 | 0.000 | | | | |
| 49 | CHR | -999 | ZW | -999.000 | 3 | 4 | 0 | 0 | 0.292 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 3.5 | | 0 | 0 | 0.000 | | | | |

STEM 7 TEST 4



TP15 - sec
TP30 - sec
TP45 - sec
CLMAX
TCLMAX - sec
QD1SEC - deg/sec**2
QDMAX - deg/sec**2
TQDMAX - sec
QMAX - deg/sec
TQMAX - sec
AOADMX - deg/sec
TADMAX - sec
AOAMX - deg
TAOAMX - sec
DELAOA - deg
TCAPTR - sec
TSETTL - sec
PS - ft/sec
ENERGY - ft
VDOTMX - kt/sec
DELV - knots
CHR
ZW
TV
MALPHA
PILOT

STEM 7 TEST 4




Note: Data available for only a single pilot,
therefore, sensitivity to pilot variability and overall sensitivity not shown.

STEM 7 TEST 4
PILOT A
LONGITUDINAL CONFIGURATION 129
LATERAL CONFIGURATION 2
CHR 4
PIO 3

It feels like it is sensitive in pitch and yet it is tracking with its nose stuck that high in the air. I'm not sure how the airplane is doing what it is doing, but it's very difficult to predict. With little tiny inputs I can hold it. If it doesn't end up inside my ±2 degree band and I have to make a significant pitch input to do my final capture, then I end up in a longitudinal PIO. If I'm lucky enough to have released the stick so that it stops the pitch rate within my ±2 degrees, then it's relatively easy to capture, but it's almost an open loop capture. So the technique is I'm looking up and using no cockpit references whatsoever, go into max power, full aft stick until the target approaches the canopy bow. So that's about 10 degrees high in my nose position, and then I'm releasing the stick to neutral, letting the pitch rate stop, and then making fine, very small longitudinal inputs as required in order to stabilize it. It feels like a normal airplane of medium speed in that it has pitch sensitivity but the general pitch control is good, and then suddenly with no visible warning it loses the ability to track. The whole thing is the timing of when I release the stick, and the handling qualities are such that you can't smoothly play it. You just have to time the release to an open loop parameter. It's almost a matter of luck as to whether you get it inside your band initially it's so unpredictable. Cooper Harper: It's controllable, up until after the end game. Is adequate performance attainable? Yes, the most overshoot I ever had was two. Generally you have one. Is it satisfactory without improvement? No. You could just make desired performance with the maximum amount of compensation. I could always meet adequate performance. I can make desired performance but only with moderate to maximum pilot compensation. The initial pitch rate is good, the initial pitch acceleration is good, the end game pitch rate is good, but when I'm attempting to slow down the pitch rate in capture it's completely unpredictable and then what would seem to be normal magnitude longitudinal pitch inputs in order to correct the errors cause PIO overshoots in both directions. So you have to compensate a tremendous amount, but if I compensate and do it right then I can maintain my desired criteria. PIO rating: The motions can be prevented or eliminated only through sacrifice to task performance and through considerable pilot attention. It's possible to get it down so it's inside my desired tolerance, but it takes considerable pilot intention and effort, and it is sacrificing the task to some degree because the PIO is what's keeping me from meeting the criteria.

STEM 7 TEST 4
PILOT A
LONGITUDINAL CONFIGURATION 130
LATERAL CONFIGURATION 2
CHR 3

Rate is good, acceleration is good. I can aggressively capture it. Magic airplane. That time I waited until the target was below my canopy bow. I used forward stick, and the nose stopped predictably where I would have expected it to. I'm going to try and use the bang bang control this time and see if I can really speed up the process. No. You can't. I have got

to lead it by a little. One overshoot but then it stops very nicely. Tracks real nicely once it's there. You got to lead it a little bit, but that's natural. Easy to capture once it's there. Nice end game handling qualities. I can put it ± a quarter of a degree if I want there. No overshoots. No PIO. The best technique is to ease the stick forward a little bit when it is coming through the canopy bow and then it stops nicely. For this particular task this is a good flying system. Predictable and easy to track once I get there. I could easily transition to a very fine tracking task. Cooper Harper: Easily controllable. Adequate performance is obtainable with a tolerable workload. In fact I was always desired. It is satisfactory without improvement. The only pilot compensation I needed to meet desired performance criteria was to learn when to start easing the stick forward in order to stop the rate. It occurs in a natural position and is fairly easy to learn. So it's just minimal pilot compensation, and I had desired performance all three out of three times. So those are just mildly unpleasant deficiencies, fairly easily compensated for. And really no PIOs.

## Summary of Design Parameters Tested for STEM 7 TEST 5

Test variables:

CAP: Indicates a variation in CAP:

(-) 0.28, Level 1/2 boundary from MIL-STD-1797A

(+) 0.60, Within the Level 1 region from MIL-STD-1797A and generally good for acquisition

ZSP: A schedule of ZSP was implemented based on AOA:

For low AOA (≤10°), ZSP maintained at:

(-) 0.35, Level 1/2 boundary from MIL-STD-1797A

(+) 0.70, Within the Level 1 region from MIL-STD-1797A and generally good for acquisition

For high AOA (30°), ZSP maintained at:

(-) 0.6, Level 1/2 boundary for high AOA maneuvering from MCAIR research

(+) 1.2, Solid Level 1 value for high AOA maneuvering from MCAIR research

LONSHP: Indicates whether or not non-linear stick shaping is being used:

(-) No shaping, longitudinal dynamics do not vary with stick position

(+) Shaping, $\omega_{sp}$ reduced and $\zeta_{sp}$ increased for for small incremental stick inputs

### Test Matrix

| Lon Config | Lat Config | CAP | ZSP | LONSHP | PLT |
|---|---|---|---|---|---|
| 158 | 2 | 0.28 (0) | 0.35/0.6 (0) | On (1) | 2,8 |
| 101 | 2 | 0.6 (1) | 0.35/0.6 (0) | Off (1) | 2,8 |
| 102 | 2 | 0.28 (0) | 0.7/1.2 (1) | Off (0) | 2,8 |
| 126 | 2 | 0.6 (1) | 0.7/1.2 (1) | On (1) | 2,8 |

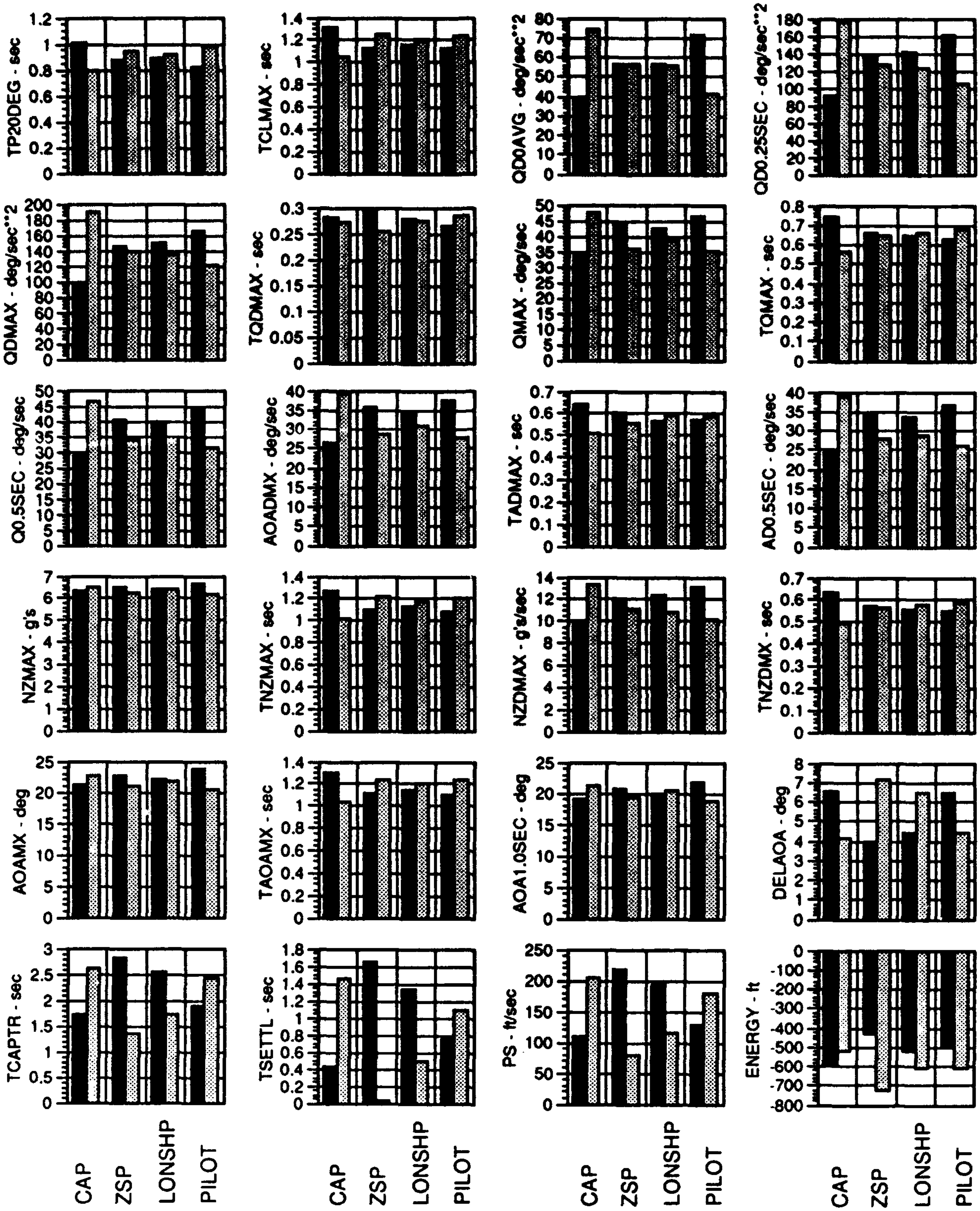
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | TPXDEG | 0.9999 | CAP | 1.000 | 1.0026 | 0.7962 | 0 | 0 | -0.233 | 1.27 | 2 | 2 | 3 |
| | (20 deg) | | ZSP | 0.985 | 0.8719 | 0.9412 | 0 | 0 | 0.077 | 0.42 | 4 | 3 | 4 |
| | | | LONSHP | 0.456 | 0.8869 | 0.9201 | 0 | 0 | 0.037 | 0.20 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 0.8184 | 0.9819 | 0 | 0 | 0.183 | | | | |
| 3 | TCLMAX | 0.9999 | CAP | 1.000 | 1.3132 | 1.0547 | 0 | 0 | -0.221 | 2.22 | 2 | 1 | 2 |
| | | | ZSP | 0.998 | 1.1323 | 1.2575 | 0 | 0 | 0.105 | 1.06 | 3 | 2 | 4 |
| | | | LONSHP | 0.592 | 1.1644 | 1.2142 | 0 | 0 | 0.042 | 0.42 | 4 | 3 | 4 |
| | | | PLT | 0.998 | 1.1275 | 1.2453 | 0 | 0 | 0.099 | | | | |
| 4 | QD0AVG | 0.9999 | CAP | 1.000 | 39.387 | 74.256 | 0 | 0 | 0.677 | 1.20 | 1 | 2 | 2 |
| | (0.25 sec) | | ZSP | 0.187 | 56.217 | 56.225 | 0 | 0 | 0.000 | 0.00 | 4 | 3 | 4 |
| | | | LONSHP | 0.432 | 56.453 | 55.971 | 0 | 0 | -0.009 | 0.02 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 71.676 | 41.796 | 0 | 0 | -0.566 | | | | |
| 5 | QDXSEC | 0.9999 | CAP | 1.000 | 90.582 | 177.7 | 0 | 0 | 0.726 | 1.65 | 1 | 2 | 2 |
| | (0.25 sec) | | ZSP | 0.463 | 136.28 | 128.17 | 0 | 0 | -0.061 | 0.14 | 4 | 3 | 4 |
| | | | LONSHP | 0.826 | 142.04 | 122.57 | 0 | 0 | -0.148 | 0.34 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 161.67 | 105.54 | 0 | 0 | -0.439 | | | | |
| 6 | QDMAX | 0.9999 | CAP | 1.000 | 98.837 | 190.28 | 0 | 0 | 0.703 | 2.14 | 1 | 1 | 1 |
| | | | ZSP | 0.607 | 146.01 | 139.25 | 0 | 0 | -0.047 | 0.14 | 4 | 3 | 4 |
| | | | LONSHP | 0.909 | 150.68 | 134.73 | 0 | 0 | -0.112 | 0.34 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 166.74 | 120.8 | 0 | 0 | -0.328 | | | | |
| 7 | TQDMAX | 0.5958 | CAP | 0.322 | 0.2809 | 0.2713 | 0 | 0 | -0.035 | 0.53 | 4 | 3 | 4 |
| | | | ZSP | 0.903 | 0.294 | 0.2545 | 0 | 0 | -0.145 | 2.19 | 3 | 1 | 3 |
| | | | LONSHP | 0.240 | 0.2784 | 0.274 | 0 | 0 | -0.016 | 0.24 | 4 | 3 | 4 |
| | | | PLT | 0.473 | 0.2669 | 0.2851 | 0 | 0 | 0.066 | | | | |
| 8 | QMAX | 0.9999 | CAP | 1.000 | 34.378 | 47.449 | 0 | 0 | 0.328 | 1.20 | 2 | 2 | 3 |
| | | | ZSP | 1.000 | 44.496 | 36.001 | 0 | 0 | -0.213 | 0.78 | 2 | 3 | 4 |
| | | | LONSHP | 0.985 | 42.499 | 38.748 | 0 | 0 | -0.093 | 0.34 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 46.369 | 35.386 | 0 | 0 | -0.274 | | | | |
| 9 | TQMAX | 0.9999 | CAP | 1.000 | 0.7441 | 0.5618 | 0 | 0 | -0.285 | 4.03 | 2 | 1 | 2 |
| | | | ZSP | 0.785 | 0.6665 | 0.6434 | 0 | 0 | -0.035 | 0.50 | 4 | 3 | 4 |
| | | | LONSHP | 0.154 | 0.6485 | 0.6643 | 0 | 0 | 0.024 | 0.34 | 4 | 3 | 4 |
| | | | PLT | 0.880 | 0.6322 | 0.6785 | 0 | 0 | 0.071 | | | | |
| 10 | QXSEC | 0.9999 | CAP | 1.000 | 28.658 | 46.392 | 0 | 0 | 0.501 | 1.50 | 1 | 2 | 2 |
| | (0.5 sec) | | ZSP | 0.999 | 40.111 | 33.66 | 0 | 0 | -0.176 | 0.53 | 3 | 3 | 4 |
| | | | LONSHP | 0.976 | 39.681 | 34.582 | 0 | 0 | -0.138 | 0.41 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 43.507 | 31.351 | 0 | 0 | -0.334 | | | | |
| 11 | AOADMX | 0.9999 | CAP | 1.000 | 26.325 | 39.527 | 0 | 0 | 0.418 | 1.39 | 1 | 2 | 2 |
| | | | ZSP | 1.000 | 35.809 | 28.87 | 0 | 0 | -0.217 | 0.72 | 2 | 3 | 4 |
| | | | LONSHP | 0.990 | 34.427 | 30.847 | 0 | 0 | -0.110 | 0.37 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 37.702 | 28.028 | 0 | 0 | -0.301 | | | | |
| 12 | TADMAX | 0.9987 | CAP | 1.000 | 0.6448 | 0.5121 | 0 | 0 | -0.232 | 8.43 | 2 | 1 | 2 |
| | | | ZSP | 0.952 | 0.6011 | 0.5557 | 0 | 0 | -0.079 | 2.85 | 4 | 1 | 4 |
| | | | LONSHP | 0.464 | 0.5658 | 0.5968 | 0 | 0 | 0.053 | 1.94 | 4 | 2 | 4 |
| | | | PLT | 0.164 | 0.5725 | 0.5885 | 0 | 0 | 0.028 | | | | |
| 13 | ADXSEC | 0.9999 | CAP | 1.000 | 24.173 | 38.888 | 0 | 0 | 0.494 | 1.45 | 1 | 2 | 2 |
| | (0.5 sec) | | ZSP | 1.000 | 33.895 | 28.055 | 0 | 0 | -0.190 | 0.56 | 3 | 3 | 4 |
| | | | LONSHP | 0.993 | 33.545 | 28.847 | 0 | 0 | -0.151 | 0.44 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 36.678 | 26.236 | 0 | 0 | -0.341 | | | | |
| 14 | NZMAX | 0.9999 | CAP | 0.978 | 6.3501 | 6.5008 | 0 | 0 | 0.023 | 0.34 | 4 | 3 | 4 |
| | | | ZSP | 0.999 | 6.5344 | 6.2856 | 0 | 0 | -0.039 | 0.56 | 4 | 3 | 4 |
| | | | LONSHP | 0.228 | 6.4341 | 6.4108 | 0 | 0 | -0.004 | 0.05 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 6.6524 | 6.2087 | 0 | 0 | -0.069 | | | | |
| 15 | TNZMAX | 0.9999 | CAP | 1.000 | 1.2769 | 1.0229 | 0 | 0 | -0.224 | 2.03 | 2 | 1 | 2 |
| | | | ZSP | 0.999 | 1.0982 | 1.2233 | 0 | 0 | 0.108 | 0.98 | 3 | 3 | 4 |
| | | | LONSHP | 0.606 | 1.1314 | 1.1788 | 0 | 0 | 0.041 | 0.37 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 1.0889 | 1.2153 | 0 | 0 | 0.110 | | | | |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | NZDMAX | 0.9999 | CAP | 1.000 | 10.035 | 13.327 | 0 | 0 | 0.288 | 1.09 | 2 | 2 | 3 |
| | | | ZSP | 0.818 | 12.038 | 11.116 | 0 | 0 | -0.080 | 0.30 | 4 | 3 | 4 |
| | | | LONSHP | 0.948 | 12.341 | 10.857 | 0 | 0 | -0.129 | 0.49 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 13.192 | 10.161 | 0 | 0 | -0.264 | | | | |
| 17 | TNZDMX | 0.9971 | CAP | 1.000 | 0.6382 | 0.4946 | 0 | 0 | -0.258 | 3.60 | 2 | 1 | 2 |
| | | | ZSP | 0.234 | 0.5704 | 0.567 | 0 | 0 | -0.006 | 0.08 | 4 | 3 | 4 |
| | | | LONSHP | 0.123 | 0.5592 | 0.5792 | 0 | 0 | 0.035 | 0.49 | 4 | 3 | 4 |
| | | | PLT | 0.752 | 0.5479 | 0.5885 | 0 | 0 | 0.072 | | | | |
| 20 | AOAMX | 0.9999 | CAP | 0.968 | 21.339 | 22.73 | 0 | 0 | 0.063 | 0.39 | 4 | 3 | 4 |
| | | | ZSP | 0.986 | 22.769 | 21.077 | 0 | 0 | -0.077 | 0.48 | 4 | 3 | 4 |
| | | | LONSHP | 0.434 | 22.217 | 21.789 | 0 | 0 | -0.019 | 0.12 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 23.828 | 20.314 | 0 | 0 | -0.160 | | | | |
| 21 | TAOAMX | 0.9999 | CAP | 1.000 | 1.2935 | 1.0406 | 0 | 0 | -0.219 | 1.84 | 2 | 2 | 3 |
| | | | ZSP | 0.998 | 1.1138 | 1.2423 | 0 | 0 | 0.109 | 0.92 | 3 | 3 | 4 |
| | | | LONSHP | 0.678 | 1.1446 | 1.2001 | 0 | 0 | 0.047 | 0.40 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 1.0994 | 1.2386 | 0 | 0 | 0.119 | | | | |
| 22 | AOAXSEC | 0.9996 | CAP | 0.997 | 19.022 | 21.402 | 0 | 0 | 0.118 | 0.76 | 3 | 3 | 4 |
| | (1.0 sec) | | ZSP | 0.908 | 20.787 | 19.413 | 0 | 0 | -0.068 | 0.44 | 4 | 3 | 4 |
| | | | LONSHP | 0.678 | 19.914 | 20.447 | 0 | 0 | 0.026 | 0.17 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 21.792 | 18.658 | 0 | 0 | -0.156 | | | | |
| 23 | DELAOA | 0.9956 | CAP | 0.986 | 6.5443 | 4.1855 | 0 | 0 | -0.462 | 1.18 | 1 | 2 | 2 |
| | | | ZSP | 0.998 | 3.9881 | 7.1501 | 0 | 0 | 0.618 | 1.58 | 1 | 2 | 2 |
| | | | LONSHP | 0.959 | 4.4324 | 6.4483 | 0 | 0 | 0.384 | 0.98 | 2 | 3 | 4 |
| | | | PLT | 0.969 | 6.4646 | 4.4171 | 0 | 0 | -0.390 | | | | |
| 25 | TCAPTR | 0.9993 | CAP | 0.990 | 1.731 | 2.6163 | 0 | 0 | 0.425 | 1.62 | 1 | 2 | 2 |
| | | | ZSP | 1.000 | 2.8191 | 1.3453 | 0 | 0 | -0.809 | 3.09 | 1 | 1 | 1 |
| | | | LONSHP | 0.982 | 2.5585 | 1.7297 | 0 | 0 | -0.402 | 1.53 | 1 | 2 | 2 |
| | | | PLT | 0.890 | 1.8722 | 2.4255 | 0 | 0 | 0.262 | | | | |
| 26 | TSETTL | 0.9996 | CAP | 0.997 | 0.4309 | 1.4581 | 0 | 0 | 1.544 | 4.15 | 1 | 1 | 1 |
| | | | ZSP | 1.000 | 1.6517 | 0.0346 | 0 | 0 | -23.843 | 64.08 | 1 | 1 | 1 |
| | | | LONSHP | 0.983 | 1.3309 | 0.4939 | 0 | 0 | -1.162 | 3.12 | 1 | 1 | 1 |
| | | | PLT | 0.638 | 0.7553 | 1.0869 | 0 | 0 | 0.372 | | | | |
| 36 | PS | 0.9894 | CAP | 0.977 | 109.92 | 204.8 | 0 | 0 | 0.663 | 1.96 | 1 | 2 | 2 |
| | | | ZSP | 0.998 | 218.38 | 78.624 | 0 | 0 | -1.209 | 3.58 | 1 | 1 | 1 |
| | | | LONSHP | 0.924 | 192.39 | 116.45 | 0 | 0 | -0.523 | 1.55 | 1 | 2 | 2 |
| | | | PLT | 0.770 | 129.41 | 180.29 | 0 | 0 | 0.338 | | | | |
| 37 | ENERGY | 0.9825 | CAP | 0.669 | -598.89 | -515.25 | 0 | 0 | 0.151 | 0.80 | 4 | 3 | 4 |
| | | | ZSP | 0.997 | -427.95 | -719.21 | 0 | 0 | -0.543 | 2.86 | 1 | 1 | 1 |
| | | | LONSHP | 0.713 | -516.11 | -603.94 | 0 | 0 | -0.158 | 0.83 | 4 | 3 | 4 |
| | | | PLT | 0.843 | -504.37 | -609.04 | 0 | 0 | -0.190 | | | | |
| 38 | VDOTMX | 0.7164 | CAP | 0.765 | -11.265 | -15.301 | 0 | 0 | -0.311 | 1.96 | 4 | 2 | 4 |
| | | | ZSP | 0.844 | -15.469 | -10.438 | 0 | 0 | 0.404 | 2.55 | 2 | 1 | 2 |
| | | | LONSHP | 0.582 | -14.626 | -11.7 | 0 | 0 | 0.225 | 1.42 | 4 | 2 | 4 |
| | | | PLT | 0.489 | -14.294 | -12.205 | 0 | 0 | 0.159 | | | | |
| 39 | DELV | 0.9996 | CAP | 0.868 | -5.7846 | -7.8072 | 0 | 0 | -0.304 | 0.26 | 3 | 3 | 4 |
| | | | ZSP | 0.436 | -6.4555 | -7.1371 | 0 | 0 | -0.101 | 0.08 | 4 | 3 | 4 |
| | | | LONSHP | 0.258 | -7.0857 | -6.4132 | 0 | 0 | 0.100 | 0.08 | 4 | 3 | 4 |
| | | | PLT | 1.000 | -3.5572 | -9.7512 | 0 | 0 | -1.188 | | | | |
| 40 | GAMDOT | 0.9886 | CAP | 0.926 | 13.01 | 13.86 | 0 | 0 | 0.063 | 0.44 | 4 | 3 | 4 |
| | | | ZSP | 0.613 | 13.256 | 13.624 | 0 | 0 | 0.027 | 0.19 | 4 | 3 | 4 |
| | | | LONSHP | 0.516 | 13.317 | 13.532 | 0 | 0 | 0.016 | 0.11 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 14.413 | 12.494 | 0 | 0 | -0.143 | | | | |
| 41 | TGAMD | 0.5982 | CAP | 0.769 | 1.2672 | 1.1318 | 0 | 0 | -0.113 | 3.26 | 4 | 1 | 4 |
| | | | ZSP | 0.832 | 1.129 | 1.2914 | 0 | 0 | 0.135 | 3.88 | 4 | 1 | 4 |
| | | | LONSHP | 0.709 | 1.1412 | 1.2667 | 0 | 0 | 0.105 | 3.01 | 4 | 1 | 4 |
| | | | PLT | 0.294 | 1.1802 | 1.2219 | 0 | 0 | 0.035 | | | | |

STEM 7 TEST 5

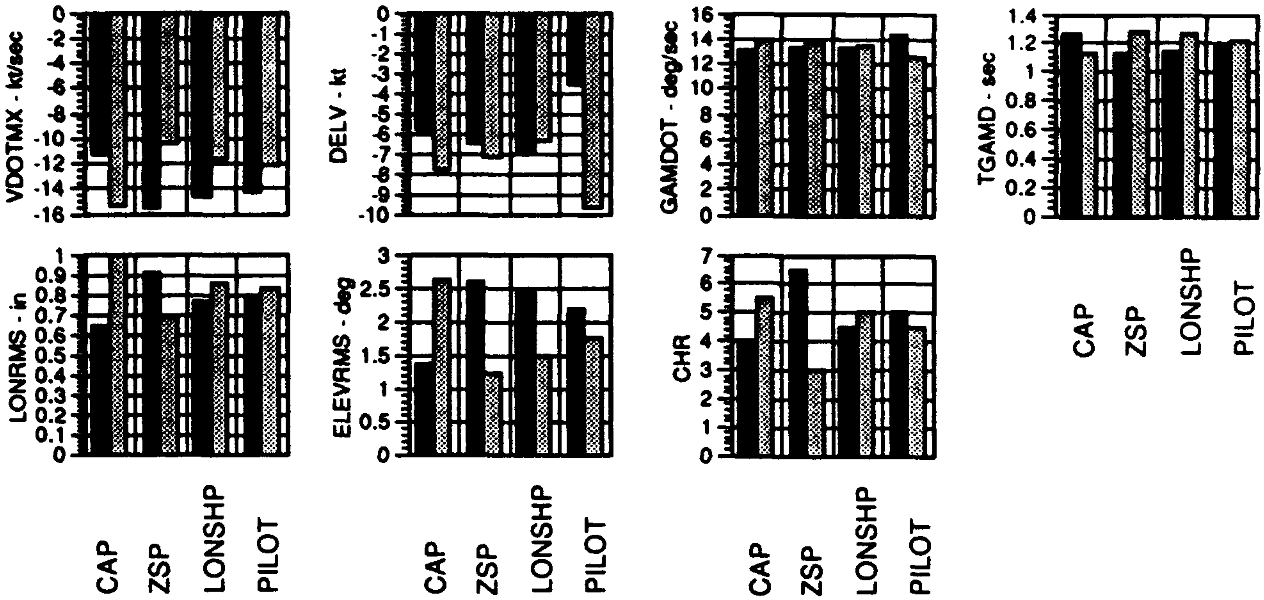
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 42 | LONRMS | 0.9971 | CAP | 0.999 | 0.6366 | 0.996 | 0 | 0 | 0.463 | 12.97 | 1 | 1 | 1 |
| | | | ZSP | 0.953 | 0.9078 | 0.6899 | 0 | 0 | -0.278 | 7.79 | 2 | 1 | 2 |
| | | | LONSHP | 0.772 | 0.7667 | 0.8567 | 0 | 0 | 0.111 | 3.12 | 4 | 1 | 4 |
| | | | PLT | 0.070 | 0.7952 | 0.8241 | 0 | 0 | 0.036 | | | | |
| 44 | ELEVRMS | 0.9999 | CAP | 1.000 | 1.3606 | 2.6245 | 0 | 0 | 0.705 | 3.12 | 1 | 1 | 1 |
| | | | ZSP | 1.000 | 2.588 | 1.2111 | 0 | 0 | -0.835 | 3.69 | 1 | 1 | 1 |
| | | | LONSHP | 0.996 | 2.421 | 1.4883 | 0 | 0 | -0.506 | 2.24 | 1 | 1 | 1 |
| | | | PLT | 0.895 | 2.1992 | 1.7575 | 0 | 0 | -0.226 | | | | |
| 49 | CHR | 0 | CAP | -999.000 | 4 | 5.5 | 0 | 0 | 0.324 | 3.07 | 4 | 1 | 4 |
| | | | ZSP | -999.000 | 6.5 | 3 | 0 | 0 | -0.853 | 8.08 | 4 | 1 | 4 |
| | | | LONSHP | -999.000 | 4.5 | 5 | 0 | 0 | 0.106 | 1.00 | 4 | 2 | 4 |
| | | | PLT | -999.000 | 5 | 4.5 | 0 | 0 | -0.106 | | | | |

## STEM 7 TEST 5

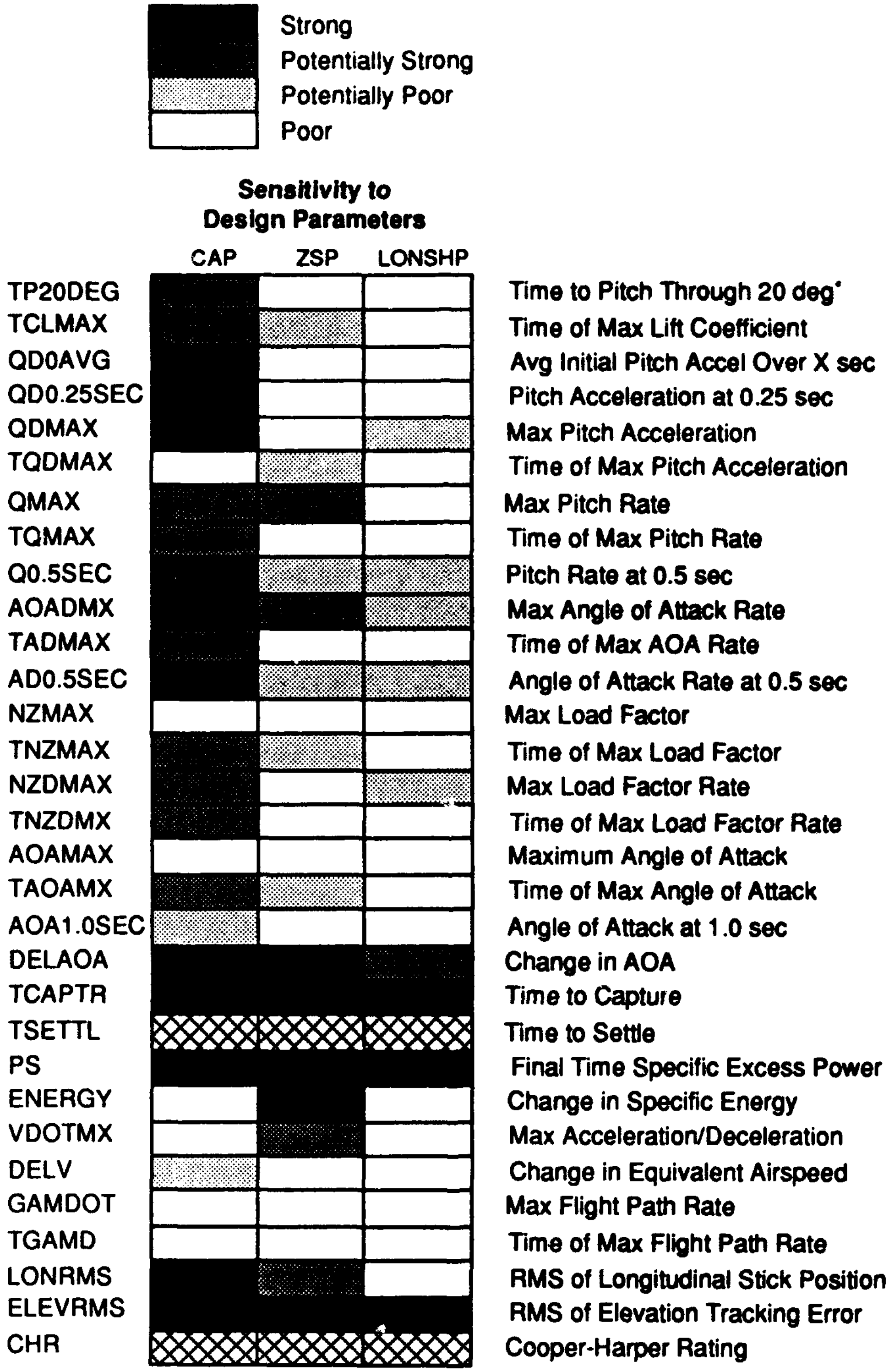


TP20DEG - sec
TCLMAX - sec
QD0AVG - deg/sec**2
QD0.25SEC - deg/sec**2
QDMAX - deg/sec**2
TQDMAX - sec
QMAX - deg/sec
TQMAX - sec
Q0.5SEC - deg/sec
AOADMX - deg/sec
TADMAX - sec
AD0.5SEC - deg/sec
NZMAX - g's
TNZMAX - sec
NZDMAX - g's/sec
TNZDMX - sec
AOAMX - deg
TAOAMX - sec
AOA1.0SEC - deg
DELAOA - deg
TCAPTR - sec
TSETTL - sec
PS - ft/sec
ENERGY - ft
CAP
ZSP
LONSHP
PILOT

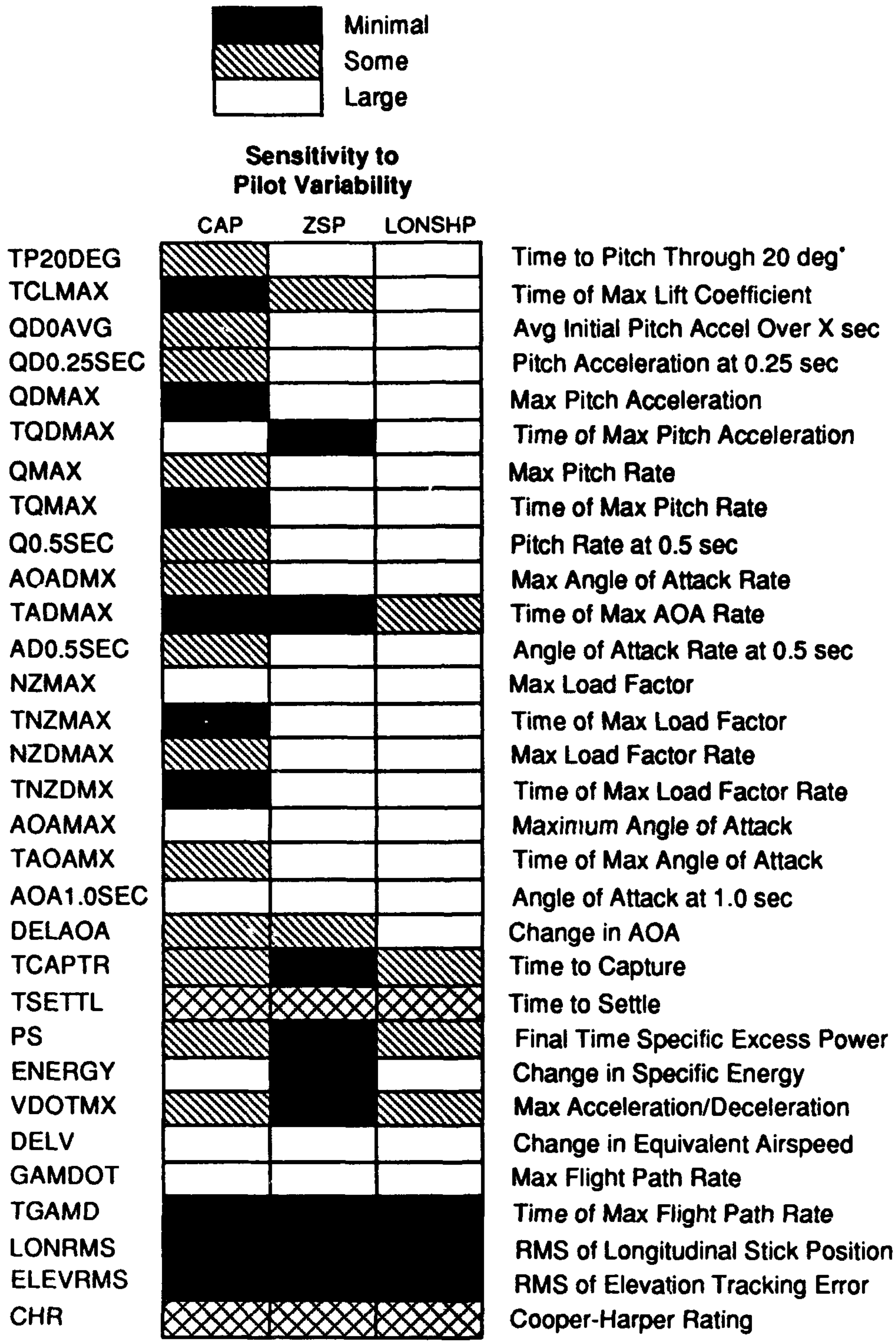
STEM 7 TEST 5


VDOTMX - kt/sec
DELV - kt
GAMDOT - deg/sec
TGAMD - sec
LONRMS - in
ELEVRMS - deg
CHR
CAP
ZSP
LONSHP
PILOT

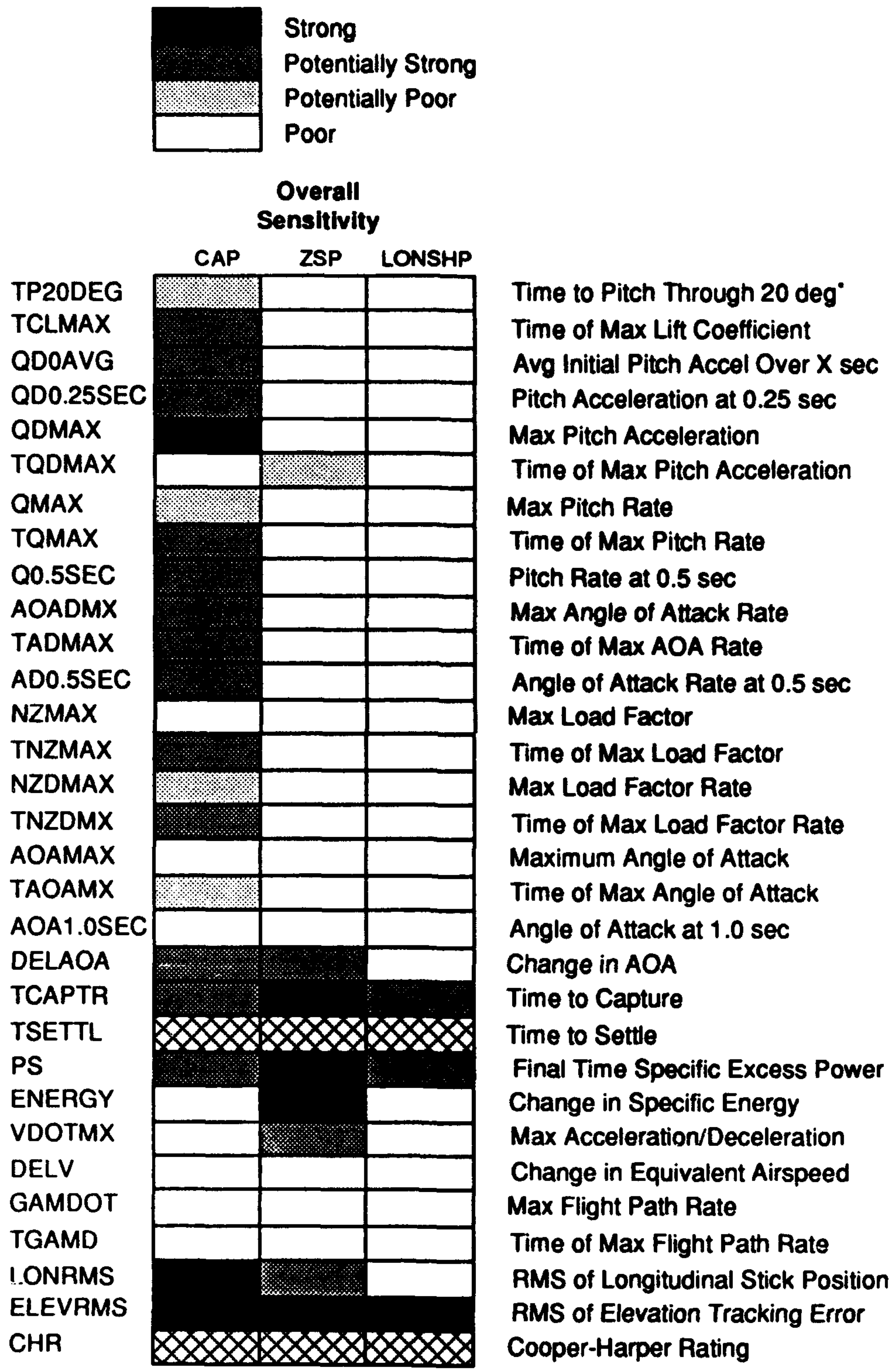
STEM 7 TEST 5


Strong
Potentially Strong
Potentially Poor
Poor
Sensitivity to Design Parameters
CAP
ZSP
LONSHP
TP20DEG
TCLMAX
QD0AVG
QD0.25SEC
QDMAX
TQDMAX
QMAX
TQMAX
Q0.5SEC
AOADMX
TADMAX
AD0.5SEC
NZMAX
TNZMAX
NZDMAX
TNZDMX
AOAMAX
TAOAMX
AOA1.0SEC
DELAOA
TCAPTR
TSETTL
PS
ENERGY
VDOTMX
DELV
GAMDOT
TGAMD
LONRMS
ELEVRMS
CHR
Time to Pitch Through 20 deg'
Time of Max Lift Coefficient
Avg Initial Pitch Accel Over X sec
Pitch Acceleration at 0.25 sec
Max Pitch Acceleration
Time of Max Pitch Acceleration
Max Pitch Rate
Time of Max Pitch Rate
Pitch Rate at 0.5 sec
Max Angle of Attack Rate
Time of Max AOA Rate
Angle of Attack Rate at 0.5 sec
Max Load Factor
Time of Max Load Factor
Max Load Factor Rate
Time of Max Load Factor Rate
Maximum Angle of Attack
Time of Max Angle of Attack
Angle of Attack at 1.0 sec
Change in AOA
Time to Capture
Time to Settle
Final Time Specific Excess Power
Change in Specific Energy
Max Acceleration/Deceleration
Change in Equivalent Airspeed
Max Flight Path Rate
Time of Max Flight Path Rate
RMS of Longitudinal Stick Position
RMS of Elevation Tracking Error
Cooper-Harper Rating

STEM 7 TEST 5


Minimal
Some
Large
Sensitivity to Pilot Variability
CAP
ZSP
LONSHP
TP20DEG
TCLMAX
QD0AVG
QD0.25SEC
QDMAX
TQDMAX
QMAX
TQMAX
Q0.5SEC
AOADMX
TADMAX
AD0.5SEC
NZMAX
TNZMAX
NZDMAX
TNZDMX
AOAMAX
TAOAMX
AOA1.0SEC
DELAOA
TCAPTR
TSETTL
PS
ENERGY
VDOTMX
DELV
GAMDOT
TGAMD
LONRMS
ELEVRMS
CHR
Time to Pitch Through 20 deg*
Time of Max Lift Coefficient
Avg Initial Pitch Accel Over X sec
Pitch Acceleration at 0.25 sec
Max Pitch Acceleration
Time of Max Pitch Acceleration
Max Pitch Rate
Time of Max Pitch Rate
Pitch Rate at 0.5 sec
Max Angle of Attack Rate
Time of Max AOA Rate
Angle of Attack Rate at 0.5 sec
Max Load Factor
Time of Max Load Factor
Max Load Factor Rate
Time of Max Load Factor Rate
Maximum Angle of Attack
Time of Max Angle of Attack
Angle of Attack at 1.0 sec
Change in AOA
Time to Capture
Time to Settle
Final Time Specific Excess Power
Change in Specific Energy
Max Acceleration/Deceleration
Change in Equivalent Airspeed
Max Flight Path Rate
Time of Max Flight Path Rate
RMS of Longitudinal Stick Position
RMS of Elevation Tracking Error
Cooper-Harper Rating

STEM 7 TEST 5


Strong
Potentially Strong
Potentially Poor
Poor
Overall Sensitivity
CAP
ZSP
LONSHP
TP20DEG
TCLMAX
QD0AVG
QD0.25SEC
QDMAX
TQDMAX
QMAX
TQMAX
Q0.5SEC
AOADMX
TADMAX
AD0.5SEC
NZMAX
TNZMAX
NZDMAX
TNZDMX
AOAMAX
TAOAMX
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Avg Initial Pitch Accel Over X sec
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Time of Max Pitch Acceleration
Max Pitch Rate
Time of Max Pitch Rate
Pitch Rate at 0.5 sec
Max Angle of Attack Rate
Time of Max AOA Rate
Angle of Attack Rate at 0.5 sec
Max Load Factor
Time of Max Load Factor
Max Load Factor Rate
Time of Max Load Factor Rate
Maximum Angle of Attack
Time of Max Angle of Attack
Angle of Attack at 1.0 sec
Change in AOA
Time to Capture
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Final Time Specific Excess Power
Change in Specific Energy
Max Acceleration/Deceleration
Change in Equivalent Airspeed
Max Flight Path Rate
Time of Max Flight Path Rate
RMS of Longitudinal Stick Position
RMS of Elevation Tracking Error
Cooper-Harper Rating

STEM 7 TEST 5
PILOT B
LONGITUDINAL CONFIGURATION 158
LATERAL CONFIGURATION 2
CHR 7
PIO 3

Good pitch rate. It has very poor predictability in terms of stopping the pitch rate. It appears that what happens is when you counter the input you can stop the pitch rate momentarily. Then when you release the input that you apply to stop the pitch rate, you bounce outside of your 80 mil criteria. I don't think we're going to get desired performance on this particular one. Again, it's got poor predictability. Unless I back off considerably on the gain of the input to stabilize the pitch at the end, this is going to be shaky for even adequate criteria due to the overshoots. You can stop it inside of 80 mils, but the tuning input that you use for more of a fine tracking bounces you right back out of the adequate criteria. Cooper-Harper: Is it controllable? Yes. Is adequate performance obtainable with a tolerable pilot workload? I'm going to say no. A major drawback is the fine tracking oscillation at the end. That is very difficult to control. In general I would say adequate performance was not obtainable at maximum tolerable pilot compensation. Control is not in question, however consistently staying under two overshoots is very difficult with typical pilot inputs. The harder you try to track the target the more intense those oscillations become. The nature of the oscillation is such that it takes you outside of your 80 mil criteria. You get a PIO that you can't stop short of basically freezing the stick at some point in the oscillation and then making a low gain input from there to bring the target back to the pipper. Okay, let's go down to the PIO rating. In high gain inputs you create an oscillation that is unpredictable in magnitude and is roughly out of phase with the stick. You are sacrificing the time to track the target, and basically you have to put all of your attention into controlling the oscillation as opposed to tracking the target.

STEM 7 TEST 5
PILOT H
LONGITUDINAL CONFIGURATION 158
LATERAL CONFIGURATION 2
CHR 5
PIO -

Very sensitive on pitch. Okay, that time I tried to use much more aft stick on the pull and so that's definitely a factor of how sensitive this thing is. Is it controllable? Yes. Is adequate performance attainable with tolerable pilot workload? Yes. Is it satisfactory without improvement? No. I got desired performance the majority of the time, but I've got objectionable deficiencies. If I ease up on the pull, I can fairly well get it between the bars. If I make an aggressive pull, I've got a really bad problem of trying to reposition the stick to get it in there. I got desired performance, but that is too sensitive in pitch.

STEM 7 TEST 5
PILOT B
LONGITUDINAL CONFIGURATION 101
LATERAL CONFIGURATION 2
CHR 7
PIO 4

The pitch rate looks good, looks kind of abrupt though. It's definitely not too slow. A loose feeling in pitch. Oscillations are very easy to drive to a larger amplitude. Cooper-Harper, is it controllable? Yes. Is adequate performance obtainable with a tolerable pilot workload? No. Deficiencies require improvement. It feels potentially like light damping but basically it manifests itself as a unpredictable oscillation greater than, in general, the 80 mil criteria. Generally speaking we're talking on the order of two to three oscillations outside of 80 mils. Adequate performance not obtainable with maximum tolerable pilot workload. Again, I don't think we're in an out of control potential here. PIO rating: Undesirable motions tend to occur. Oscillations develop and you must reduce gain or abandon task to recover. The oscillation on this one is a bit worse than it was on the previous case (longitudinal configuration 158). The initial input is not the problem. It's the small inputs at the end when I'm trying to fine tune it that are the problem. Backing off on the initial input to try to lead the response made no difference, in my opinion, on either scale. The problem on this one is the small inputs at the end are enough to drive you outside of the tolerances.

STEM 7 TEST 5
PILOT H
LONGITUDINAL CONFIGURATION 101
LATERAL CONFIGURATION 2
CHR 7
PIO 3

This seems a little bit worse than the other one (Longitudinal configuration 101). There seems like there is a lag in the system. It's not really a sensitivity problem. There I had it pegged, I had the circle on the guy and froze the stick and then it moved after that. It's having a problem keeping up with the inputs, I think. I can get it in there and it stays in there for a moment. And then the nightmare starts. I am trying to find the correct position of the stick to freeze it in there. Is it controllable? Yes. Is adequate performance attainable with a tolerable pilot workload? No. Do deficiencies require improvement? Yes. Control wasn't in question. Adequate performance was not obtainable--not really. I got adequate a couple times, but that was lucky. There's too much of a a PIO because of a time delay or something like that. The pitch control doesn't respond to the stick. It's a couple of potatoes behind. And so, it's definitely a major deficiency. Undesirable motions usually induced. The motion is prevented or eliminated only at sacrifice of task performance.

STEM 7 TEST 5
PILOT B
LONGITUDINAL CONFIGURATION 102
LATERAL CONFIGURATION 2
CHR 2
PIO 1

Build me one of these. This one is extremely predictable, a very tight feeling in pitch. Initial appearance is that capturing inside of 80 mils is no problem whatsoever. In fact you could capture inside of about 30 or 40 mils without any problems. Let's go on to the scale. Controllable, eminently so. Adequate performance? Yes. Satisfactory without improvement? Yes. I'm going to call that good characteristics, negligible deficiency. Pilot compensation not a factor for desired performance. It required just a little bit of input control for the fine tracking portion of that, but it's very predictable. I can consistently stop it well inside the 80 mils. Then tuning it from there is just a couple of small inputs that don't drive anything significantly bad at all. PIO rating - no significant oscillation. That was good. It was predictable. The major limitation on that particular set up is looking around the canopy bow to see the target fast enough to do something about it.

STEM 7 TEST 5
PILOT H
LONGITUDINAL CONFIGURATION 102
LATERAL CONFIGURATION 2
CHR 2
PIO -

It seemed to have kind of a slow pitch rate. A bit sluggish, but it stopped when I wanted it to. We'll be a bit more aggressive this time. That was almost full aft stick and I got a controllable rate and it stopped right where I wanted it. No overshoots. As soon as the target is in the box, I release the aft stick and bump it forward just a little bit and then back to neutral and it's been working. Is it controllable? Yes. Is adequate performance attainable? Yes. Is it satisfactory without improvement? Yes. I have to compensate a little bit. The pitch rate is quick. It's not as fast as the other ones, but it's definitely decent. Well, actually, it's pretty good. And desired performance was a piece of cake really. But I was still compensating to get right in there. That one time I missed it by one, so, I'm going to give it a good negligible with deficiencies rating. I was able to use full aft stick on that one and then when I came off, boom, it stopped pretty good. It wasn't full aft stick for real long.

STEM 7 TEST 5
PILOT B
LONGITUDINAL CONFIGURATION 126
LATERAL CONFIGURATION 2
CHR 4
PIO 2

This one is not quite as tight as the other one (longitudinal configuration 102). Just a little bit of a tendency to wobble a little bit more, but it's predictable and it's inside of desirable criteria. There is more oscillation present here. However, it's controllable inside the desired

criteria. No overshoots outside of that area. Cooper-Harper: Is it controllable? Yes. Adequate performance? Yes. Satisfactory without improvement? No. Minor but annoying deficiencies, desired performance is obtainable with moderate pilot compensation. The initial task of capturing inside of 80 mils with no overshoots is not a problem. Staying inside of there can potentially be a problem depending on pilot gain. You need to turn your gain just a bit and watch the aggressiveness of the inputs to stay inside of 80. Pitch rate looks acceptable. Undesirable motions tend to occur, they can be prevented or eliminated by pilot technique. There is technique involved in minimizing the effects of the oscillation, but they don't significantly affect the task.

STEM 7 TEST 5
PILOT H
LONGITUDINAL CONFIGURATION 126
LATERAL CONFIGURATION 2
CHR 4
PIO 2

A little bit more sensitive in pitch there at the end. The pitch rate seems to be about the same as the previous (Longitudinal configuration 102). A couple more overshoots on that one. That time I had it in the box there and had the stick frozen and it moved on me. I had to make one more last correction. A little bobble there. I'm able to keep it within the bars, but I'm moving the stick back and forth because I'm getting 10 to 20 mil overshoots there. It's staying within the big picture, but I am definitely having to move the stick around. Is it controllable? Yes. Is adequate performance attainable? Yes. Is it satisfactory without improvement? No. I am getting desired performance, but I've got to come off the stick and I'm moving the stick around too much because it's bobbling around inside there. Just a little PIO in there right where we're trying to stop it. And I'll give it a PIO rating. Undesirable motion tend to occur. These motions can be prevented? They really can't be prevented or eliminated but I can keep it to a small amplitude and I can still do the task.

## Summary of Design Parameters Tested for STEM 7 TEST 6

Test variables:

CAP: Indicates a variation in CAP:
(-) 0.28, Level 1/2 boundary from MIL-STD-1797A
(+) 0.60, Within the Level 1 region from MIL-STD-1797A and generally good for acquisition

ZSP: A schedule of ZSP was implemented based on AOA:
For low AOA (≤10°), ZSP maintained at:
(-) 0.35, Level 1/2 boundary from MIL-STD-1797A
(+) 0.70, Within the Level 1 region from MIL-STD-1797A and generally good for acquisition

For high AOA (30°), ZSP maintained at:
(-) 0.6, Level 1/2 boundary for high AOA maneuvering from MCAIR research
(+) 1.2, Solid Level 1 value for high AOA maneuvering from MCAIR research

LONSHP: Indicates whether or not non-linear stick shaping is being used:
(-) No shaping, longitudinal dynamics do not vary with stick position
(+) Shaping, $\omega_{sp}$ reduced and $\zeta_{sp}$ increased for for small incremental stick inputs

### Test Matrix (Pilots A,E)

| Lon Config | Lat Config | CAP | ZSP | LONSHP |
|---|---|---|---|---|
| 158 | 2 | 0.28 (-) | 0.35/0.6 (-) | On (+) |
| 101 | 2 | 0.6 (+) | 0.35/0.6 (-) | Off (-) |
| 102 | 2 | 0.28 (-) | 0.7/1.2 (+) | Off (-) |
| 126 | 2 | 0.6 (+) | 0.7/1.2 (+) | On (+) |

STEM 7 TEST 6

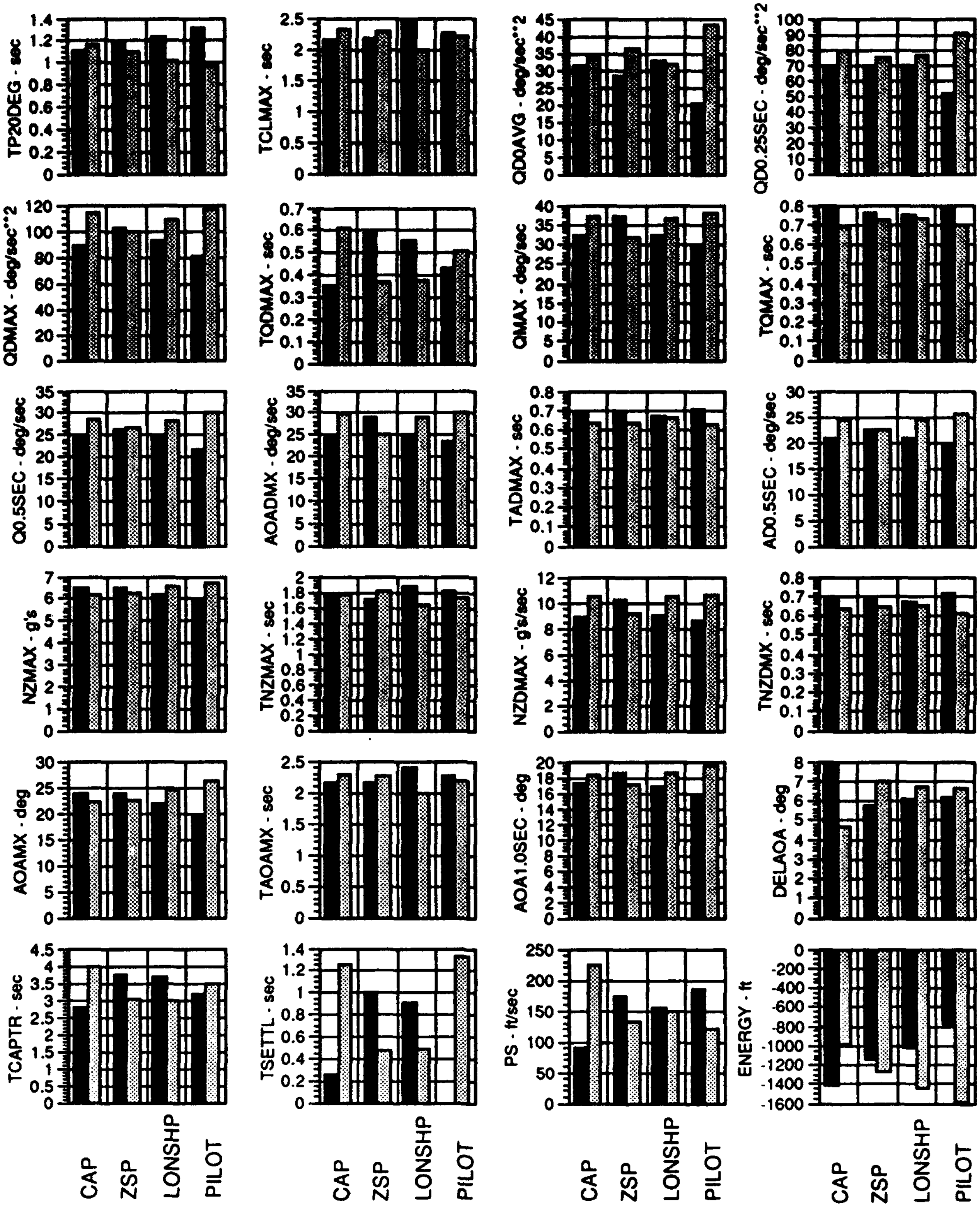
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | TPXDEG | 0.9999 | CAP | 0.576 | 1.1135 | 1.1677 | 0 | 0 | 0.048 | 0.16 | 4 | 3 | 4 |
| | (20 deg) | | ZSP | 0.787 | 1.1865 | 1.0975 | 0 | 0 | -0.078 | 0.26 | 4 | 3 | 4 |
| | | | LONSHP | 0.998 | 1.2408 | 1.0192 | 0 | 0 | -0.198 | 0.65 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 1.3224 | 0.981 | 0 | 0 | -0.303 | | | | |
| 3 | TCLMAX | 0.8313 | CAP | 0.579 | 2.1524 | 2.3278 | 0 | 0 | 0.078 | 2.42 | 4 | 1 | 4 |
| | | | ZSP | 0.413 | 2.1768 | 2.2818 | 0 | 0 | 0.047 | 1.45 | 4 | 2 | 4 |
| | | | LONSHP | 0.949 | 2.4362 | 1.9968 | 0 | 0 | -0.200 | 6.18 | 2 | 1 | 2 |
| | | | PLT | 0.343 | 2.2724 | 2.1999 | 0 | 0 | -0.032 | | | | |
| 4 | QD0AVG | 0.8945 | CAP | 0.295 | 31.281 | 33.959 | 0 | 0 | 0.082 | 0.10 | 4 | 3 | 4 |
| | (0.25 sec) | | ZSP | 0.742 | 28.246 | 36.177 | 0 | 0 | 0.250 | 0.30 | 4 | 3 | 4 |
| | | | LONSHP | 0.081 | 33.007 | 31.945 | 0 | 0 | -0.033 | 0.04 | 4 | 3 | 4 |
| | | | PLT | 0.996 | 20.142 | 43.123 | 0 | 0 | 0.837 | | | | |
| 5 | QDXSEC | 0.7675 | CAP | 0.559 | 66.955 | 79.267 | 0 | 0 | 0.170 | 0.28 | 4 | 3 | 4 |
| | (0.25 sec) | | ZSP | 0.333 | 69.44 | 75.379 | 0 | 0 | 0.082 | 0.14 | 4 | 3 | 4 |
| | | | LONSHP | 0.275 | 69.882 | 75.853 | 0 | 0 | 0.082 | 0.14 | 4 | 3 | 4 |
| | | | PLT | 0.982 | 51.318 | 90.912 | 0 | 0 | 0.604 | | | | |
| 6 | QDMAX | 0.9999 | CAP | 0.999 | 88.439 | 114.23 | 0 | 0 | 0.259 | 0.67 | 2 | 3 | 4 |
| | | | ZSP | 0.113 | 101.82 | 99.072 | 0 | 0 | -0.027 | 0.07 | 4 | 3 | 4 |
| | | | LONSHP | 0.956 | 93.196 | 108.68 | 0 | 0 | 0.154 | 0.40 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 80.551 | 117.3 | 0 | 0 | 0.385 | | | | |
| 7 | TQDMAX | 0.7995 | CAP | 0.867 | 0.3529 | 0.6102 | 0 | 0 | 0.575 | 3.53 | 2 | 1 | 2 |
| | | | ZSP | 0.759 | 0.588 | 0.3719 | 0 | 0 | -0.474 | 2.90 | 4 | 1 | 4 |
| | | | LONSHP | 0.790 | 0.5547 | 0.3747 | 0 | 0 | -0.403 | 2.47 | 4 | 1 | 4 |
| | | | PLT | 0.431 | 0.4307 | 0.5067 | 0 | 0 | 0.163 | | | | |
| 8 | QMAX | 0.9999 | CAP | 0.997 | 32.087 | 36.973 | 0 | 0 | 0.142 | 0.62 | 3 | 3 | 4 |
| | | | ZSP | 0.997 | 37.056 | 32.015 | 0 | 0 | -0.147 | 0.64 | 3 | 3 | 4 |
| | | | LONSHP | 0.987 | 32.279 | 36.749 | 0 | 0 | 0.130 | 0.57 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 30.199 | 37.893 | 0 | 0 | 0.229 | | | | |
| 9 | TQMAX | 0.9768 | CAP | 0.991 | 0.788 | 0.6905 | 0 | 0 | -0.133 | 1.06 | 3 | 2 | 4 |
| | | | ZSP | 0.802 | 0.7633 | 0.7256 | 0 | 0 | -0.051 | 0.40 | 4 | 3 | 4 |
| | | | LONSHP | 0.282 | 0.7505 | 0.7343 | 0 | 0 | -0.022 | 0.17 | 4 | 3 | 4 |
| | | | PLT | 0.991 | 0.7932 | 0.6999 | 0 | 0 | -0.125 | | | | |
| 10 | QXSEC | 0.9385 | CAP | 0.769 | 24.462 | 28.645 | 0 | 0 | 0.159 | 0.47 | 4 | 3 | 4 |
| | (0.5 sec) | | ZSP | 0.135 | 26.241 | 26.522 | 0 | 0 | 0.011 | 0.03 | 4 | 3 | 4 |
| | | | LONSHP | 0.688 | 24.662 | 28.411 | 0 | 0 | 0.142 | 0.42 | 4 | 3 | 4 |
| | | | PLT | 0.986 | 21.76 | 30.363 | 0 | 0 | 0.339 | | | | |
| 11 | AOADMX | 0.9999 | CAP | 1.000 | 24.5 | 29.955 | 0 | 0 | 0.202 | 0.81 | 2 | 3 | 4 |
| | | | ZSP | 0.993 | 29.052 | 25.274 | 0 | 0 | -0.140 | 0.56 | 3 | 3 | 4 |
| | | | LONSHP | 0.989 | 25.282 | 29.043 | 0 | 0 | 0.139 | 0.56 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 23.472 | 30.057 | 0 | 0 | 0.250 | | | | |
| 12 | TADMAX | 0.8945 | CAP | 0.855 | 0.689 | 0.6366 | 0 | 0 | -0.079 | 0.69 | 4 | 3 | 4 |
| | | | ZSP | 0.949 | 0.7013 | 0.6335 | 0 | 0 | -0.102 | 0.89 | 3 | 3 | 4 |
| | | | LONSHP | 0.229 | 0.669 | 0.6599 | 0 | 0 | -0.014 | 0.12 | 4 | 3 | 4 |
| | | | PLT | 0.960 | 0.7057 | 0.6297 | 0 | 0 | -0.114 | | | | |
| 13 | ADXSEC | 0.9597 | CAP | 0.808 | 20.93 | 24.492 | 0 | 0 | 0.158 | 0.55 | 4 | 3 | 4 |
| | (0.5 sec) | | ZSP | 0.057 | 22.608 | 22.545 | 0 | 0 | -0.003 | 0.01 | 4 | 3 | 4 |
| | | | LONSHP | 0.789 | 20.898 | 24.528 | 0 | 0 | 0.161 | 0.56 | 4 | 3 | 4 |
| | | | PLT | 0.982 | 19.178 | 25.484 | 0 | 0 | 0.288 | | | | |
| 14 | NZMAX | 0.9999 | CAP | 1.000 | 6.5426 | 6.2076 | 0 | 0 | -0.053 | 0.42 | 4 | 3 | 4 |
| | | | ZSP | 1.000 | 6.5295 | 6.2667 | 0 | 0 | -0.041 | 0.33 | 4 | 3 | 4 |
| | | | LONSHP | 1.000 | 6.2033 | 6.6034 | 0 | 0 | 0.063 | 0.50 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 5.9631 | 6.7522 | 0 | 0 | 0.125 | | | | |
| 15 | TNZMAX | 0.964 | CAP | 0.054 | 1.7774 | 1.7662 | 0 | 0 | -0.006 | 0.12 | 4 | 3 | 4 |
| | | | ZSP | 0.499 | 1.7113 | 1.8244 | 0 | 0 | 0.064 | 1.22 | 4 | 2 | 4 |
| | | | LONSHP | 0.845 | 1.8878 | 1.6373 | 0 | 0 | -0.143 | 2.72 | 4 | 1 | 4 |
| | | | PLT | 0.517 | 1.8224 | 1.7292 | 0 | 0 | -0.053 | | | | |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | NZDMAX | 0.9999 | CAP | 0.999 | 8.9311 | 10.5 | 0 | 0 | 0.163 | 0.77 | 3 | 3 | 4 |
| | | | ZSP | 0.968 | 10.2 | 9.1883 | 0 | 0 | -0.105 | 0.49 | 3 | 3 | 4 |
| | | | LONSHP | 0.997 | 8.9771 | 10.447 | 0 | 0 | 0.152 | 0.72 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 8.5735 | 10.583 | 0 | 0 | 0.212 | | | | |
| 17 | TNZDMX | 0.9826 | CAP | 0.916 | 0.6855 | 0.6326 | 0 | 0 | -0.080 | 0.50 | 4 | 3 | 4 |
| | | | ZSP | 0.822 | 0.6808 | 0.6442 | 0 | 0 | -0.055 | 0.34 | 4 | 3 | 4 |
| | | | LONSHP | 0.424 | 0.6691 | 0.6517 | 0 | 0 | -0.026 | 0.16 | 4 | 3 | 4 |
| | | | PLT | 0.999 | 0.7182 | 0.6121 | 0 | 0 | -0.161 | | | | |
| 20 | AOAMX | 0.9999 | CAP | 1.000 | 23.744 | 22.309 | 0 | 0 | -0.062 | 0.21 | 4 | 3 | 4 |
| | | | ZSP | 1.000 | 23.749 | 22.51 | 0 | 0 | -0.054 | 0.18 | 4 | 3 | 4 |
| | | | LONSHP | 1.000 | 21.893 | 24.469 | 0 | 0 | 0.111 | 0.37 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 19.426 | 26.215 | 0 | 0 | 0.304 | | | | |
| 21 | TAOAMX | 0.8493 | CAP | 0.539 | 2.1454 | 2.303 | 0 | 0 | 0.071 | 2.03 | 4 | 1 | 4 |
| | | | ZSP | 0.447 | 2.1563 | 2.2712 | 0 | 0 | 0.052 | 1.49 | 4 | 2 | 4 |
| | | | LONSHP | 0.950 | 2.4186 | 1.9843 | 0 | 0 | -0.199 | 5.71 | 3 | 1 | 3 |
| | | | PLT | 0.370 | 2.2599 | 2.1824 | 0 | 0 | -0.035 | | | | |
| 22 | AOAXSEC | 0.9999 | CAP | 0.868 | 17.166 | 18.306 | 0 | 0 | 0.064 | 0.27 | 4 | 3 | 4 |
| | (1.0 sec) | | ZSP | 0.943 | 18.525 | 16.979 | 0 | 0 | -0.087 | 0.37 | 4 | 3 | 4 |
| | | | LONSHP | 0.950 | 16.914 | 18.6 | 0 | 0 | 0.095 | 0.41 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 15.508 | 19.565 | 0 | 0 | 0.234 | | | | |
| 23 | DELAOA | 0.8635 | CAP | 0.991 | 7.9186 | 4.6587 | 0 | 0 | -0.556 | 8.33 | 1 | 1 | 1 |
| | | | ZSP | 0.622 | 5.749 | 6.9841 | 0 | 0 | 0.196 | 2.94 | 4 | 1 | 4 |
| | | | LONSHP | 0.577 | 6.1336 | 6.7412 | 0 | 0 | 0.095 | 1.42 | 4 | 2 | 4 |
| | | | PLT | 0.130 | 6.1846 | 6.6107 | 0 | 0 | 0.067 | | | | |
| 25 | TCAPTR | 0.985 | CAP | 0.997 | 2.7764 | 4.0043 | 0 | 0 | 0.374 | 4.60 | 2 | 1 | 2 |
| | | | ZSP | 0.907 | 3.7277 | 3.0135 | 0 | 0 | -0.214 | 2.63 | 2 | 1 | 2 |
| | | | LONSHP | 0.969 | 3.6646 | 2.9682 | 0 | 0 | -0.212 | 2.61 | 2 | 1 | 2 |
| | | | PLT | 0.665 | 3.1974 | 3.4681 | 0 | 0 | 0.081 | | | | |
| 26 | TSETTL | 0.9991 | CAP | 0.991 | 0.26 | 1.2541 | 0 | 0 | 2.309 | #DIV/0! | 1 | | 4 |
| | | | ZSP | 0.804 | 1.0041 | 0.4742 | 0 | 0 | -0.822 | #DIV/0! | 2 | | 4 |
| | | | LONSHP | 0.863 | 0.9169 | 0.4877 | 0 | 0 | -0.674 | #DIV/0! | 2 | | 4 |
| | | | PLT | 0.999 | 0 | 1.3349 | 0 | 0 | 0.000 | | | | |
| 36 | PS | 0.9319 | CAP | 0.995 | 89.332 | 223.07 | 0 | 0 | 1.048 | 2.38 | 1 | 1 | 1 |
| | | | ZSP | 0.520 | 172.63 | 132.56 | 0 | 0 | -0.267 | 0.61 | 4 | 3 | 4 |
| | | | LONSHP | 0.299 | 153.31 | 148.42 | 0 | 0 | -0.032 | 0.07 | 4 | 3 | 4 |
| | | | PLT | 0.783 | 185.8 | 121.28 | 0 | 0 | -0.440 | | | | |
| 37 | ENERGY | 0.9999 | CAP | 0.999 | -1404.2 | -990.61 | 0 | 0 | 0.356 | 0.45 | 2 | 3 | 4 |
| | | | ZSP | 0.714 | -1138.7 | -1277.3 | 0 | 0 | -0.115 | 0.15 | 4 | 3 | 4 |
| | | | LONSHP | 1.000 | -1013.8 | -1446.1 | 0 | 0 | -0.363 | 0.46 | 2 | 3 | 4 |
| | | | PLT | 1.000 | -770.35 | -1593 | 0 | 0 | -0.792 | | | | |
| 38 | VDOTMX | 0.9999 | CAP | 0.959 | -15.965 | -10.515 | 0 | 0 | 0.430 | 0.11 | 1 | 3 | 3 |
| | | | ZSP | 0.765 | -14.877 | -12.226 | 0 | 0 | 0.198 | 0.05 | 4 | 3 | 4 |
| | | | LONSHP | 0.997 | -9.6907 | -17.835 | 0 | 0 | -0.649 | 0.17 | 1 | 3 | 3 |
| | | | PLT | 1.000 | -2.9018 | -22.49 | 0 | 0 | -3.811 | | | | |
| 39 | DELV | 0.9999 | CAP | 0.028 | -25.107 | -25.063 | 0 | 0 | 0.002 | 0.00 | 4 | 3 | 4 |
| | | | ZSP | 0.911 | -26.308 | -24.04 | 0 | 0 | 0.090 | 0.12 | 4 | 3 | 4 |
| | | | LONSHP | 0.997 | -23.034 | -27.481 | 0 | 0 | -0.177 | 0.23 | 3 | 3 | 4 |
| | | | PLT | 1.000 | -16.012 | -32.865 | 0 | 0 | -0.783 | | | | |
| 40 | GAMDOT | 0.9999 | CAP | 1.000 | 13.18 | 12.408 | 0 | 0 | -0.060 | 0.47 | 4 | 3 | 4 |
| | | | ZSP | 0.998 | 13.028 | 12.649 | 0 | 0 | -0.030 | 0.23 | 4 | 3 | 4 |
| | | | LONSHP | 1.000 | 12.366 | 13.357 | 0 | 0 | 0.077 | 0.60 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 11.938 | 13.582 | 0 | 0 | 0.129 | | | | |
| 41 | TGAMD | 0.9717 | CAP | 0.222 | 1.9185 | 1.9775 | 0 | 0 | 0.030 | 0.53 | 4 | 3 | 4 |
| | | | ZSP | 0.492 | 1.873 | 2.0081 | 0 | 0 | 0.070 | 1.22 | 4 | 2 | 4 |
| | | | LONSHP | 0.867 | 2.0971 | 1.7691 | 0 | 0 | -0.171 | 2.99 | 4 | 1 | 4 |
| | | | PLT | 0.486 | 2.0057 | 1.8943 | 0 | 0 | -0.057 | | | | |

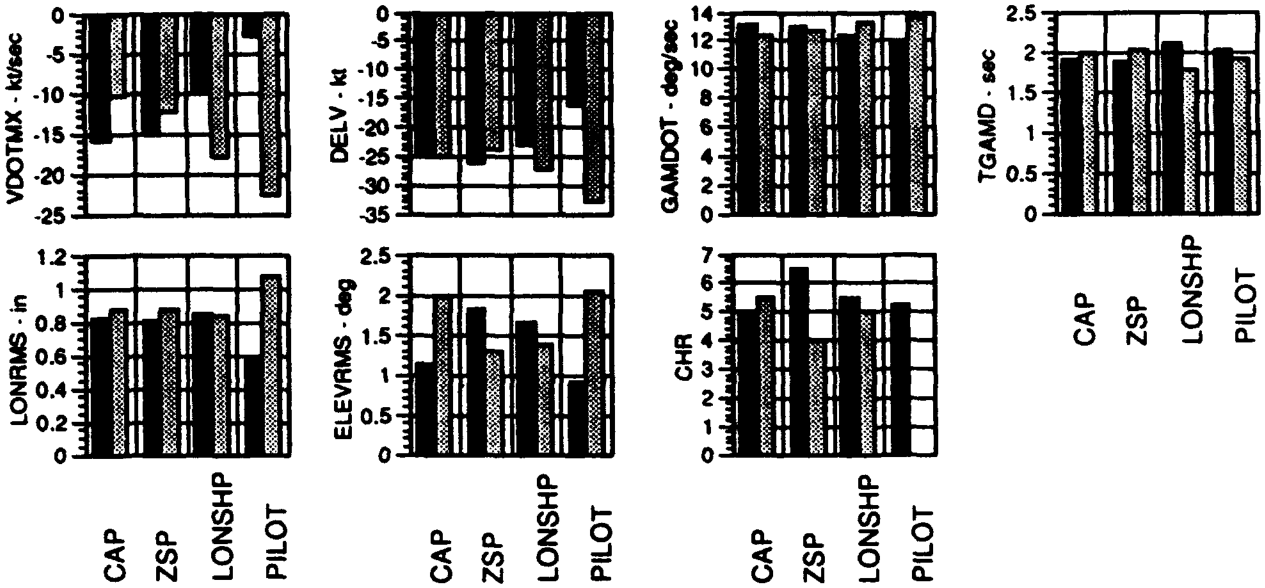
STEM 7 TEST 6

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 42 | LONRMS | 0.9983 | CAP | 0.499 | 0.8181 | 0.8773 | 0 | 0 | 0.070 | 0.10 | 4 | 3 | 4 |
| | | | ZSP | 0.528 | 0.8137 | 0.8727 | 0 | 0 | 0.070 | 0.10 | 4 | 3 | 4 |
| | | | LONSHP | 0.093 | 0.8501 | 0.84 | 0 | 0 | -0.012 | 0.02 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 0.5726 | 1.0793 | 0 | 0 | 0.677 | | | | |
| 44 | ELEVRMS | 0.9999 | CAP | 1.000 | 1.1268 | 1.9951 | 0 | 0 | 0.603 | 0.67 | 1 | 3 | 3 |
| | | | ZSP | 0.966 | 1.8113 | 1.2843 | 0 | 0 | -0.351 | 0.39 | 2 | 3 | 4 |
| | | | LONSHP | 0.905 | 1.6493 | 1.3855 | 0 | 0 | -0.175 | 0.20 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 0.9153 | 2.0523 | 0 | 0 | 0.898 | | | | |
| 49 | CHR | 0 | CAP | -999.000 | 5 | 5.5 | 0 | 0 | 0.095 | 0.00 | 4 | 3 | 4 |
| | | | ZSP | -999.000 | 6.5 | 4 | 0 | 0 | -0.505 | 0.01 | 4 | 3 | 4 |
| | | | LONSHP | -999.000 | 5.5 | 5 | 0 | 0 | -0.095 | 0.00 | 4 | 3 | 4 |
| | | | PLT | -999.000 | 5.25 | -999 | 0 | 0 | -96.145 | | | | |

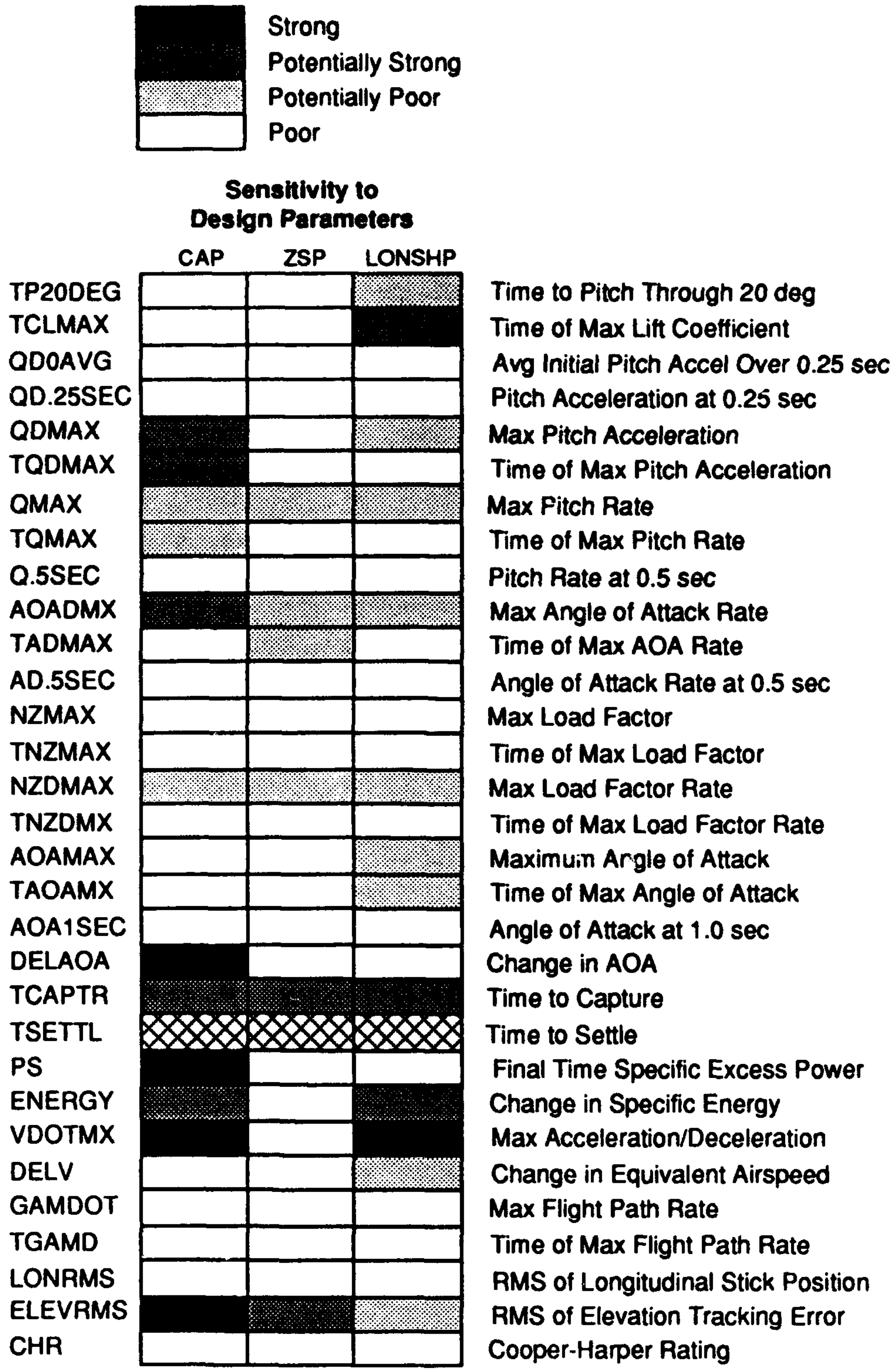
STEM 7 TEST 6


TP20DEG - sec
TCLMAX - sec
QD0AVG - deg/sec**2
QD0.25SEC - deg/sec**2
QDMAX - deg/sec**2
TQDMAX - sec
QMAX - deg/sec
TQMAX - sec
Q0.5SEC - deg/sec
AOADMX - deg/sec
TADMAX - sec
AD0.5SEC - deg/sec
NZMAX - g's
TNZMAX - sec
NZDMAX - g's/sec
TNZDMX - sec
AOAMX - deg
TAOAMX - sec
AOA1.0SEC - deg
DELAOA - deg
TCAPTR - sec
TSETTL - sec
PS - ft/sec
ENERGY - ft
CAP
ZSP
LONSHP
PILOT

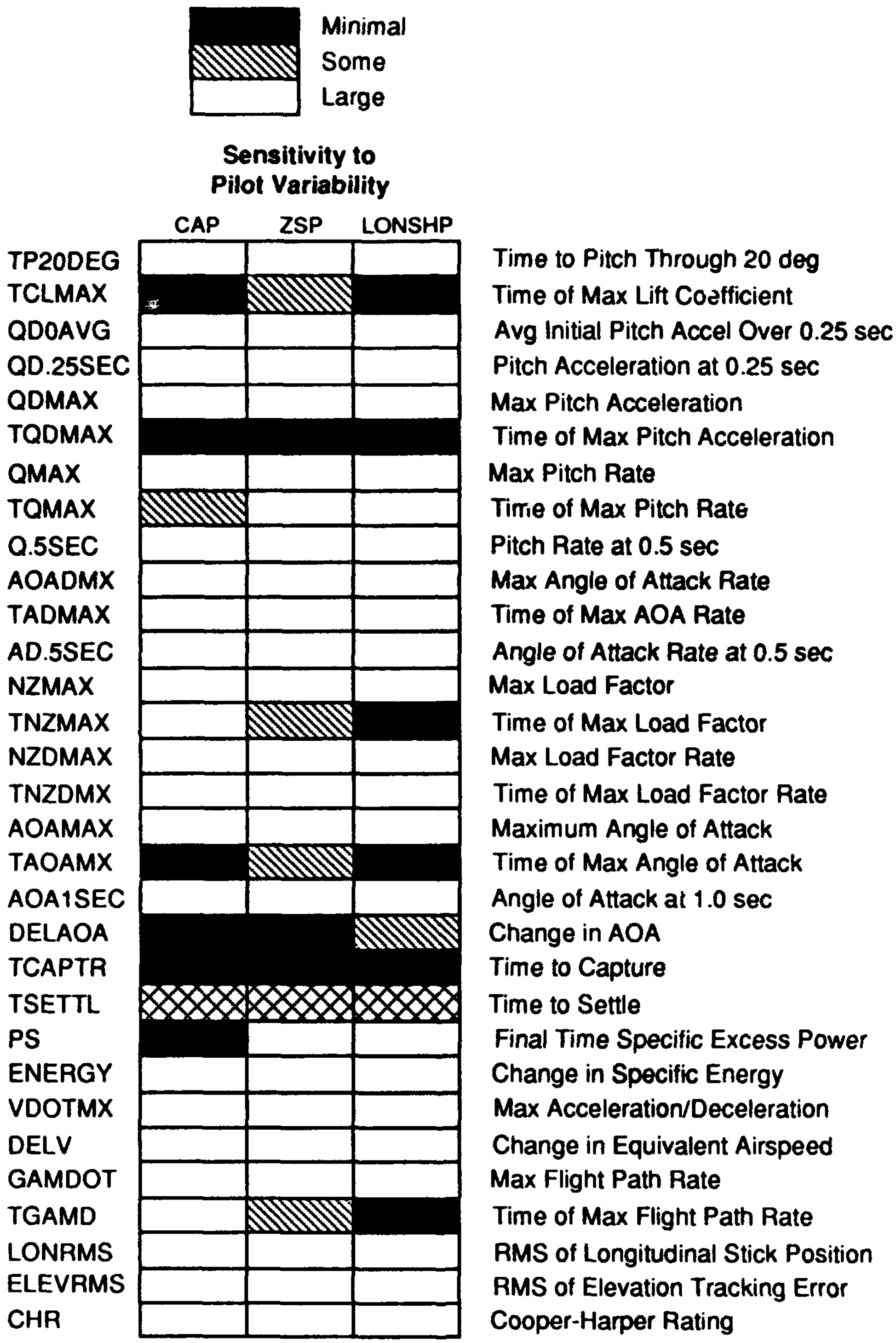
STEM 7 TEST 6


VDOTMX - kt/sec
DELV - kt
GAMIDOT - deg/sec
TGAMD - sec
LONRMS - in
ELEVRMS - deg
CHR
CAP
ZSP
LONSHP
PILOT

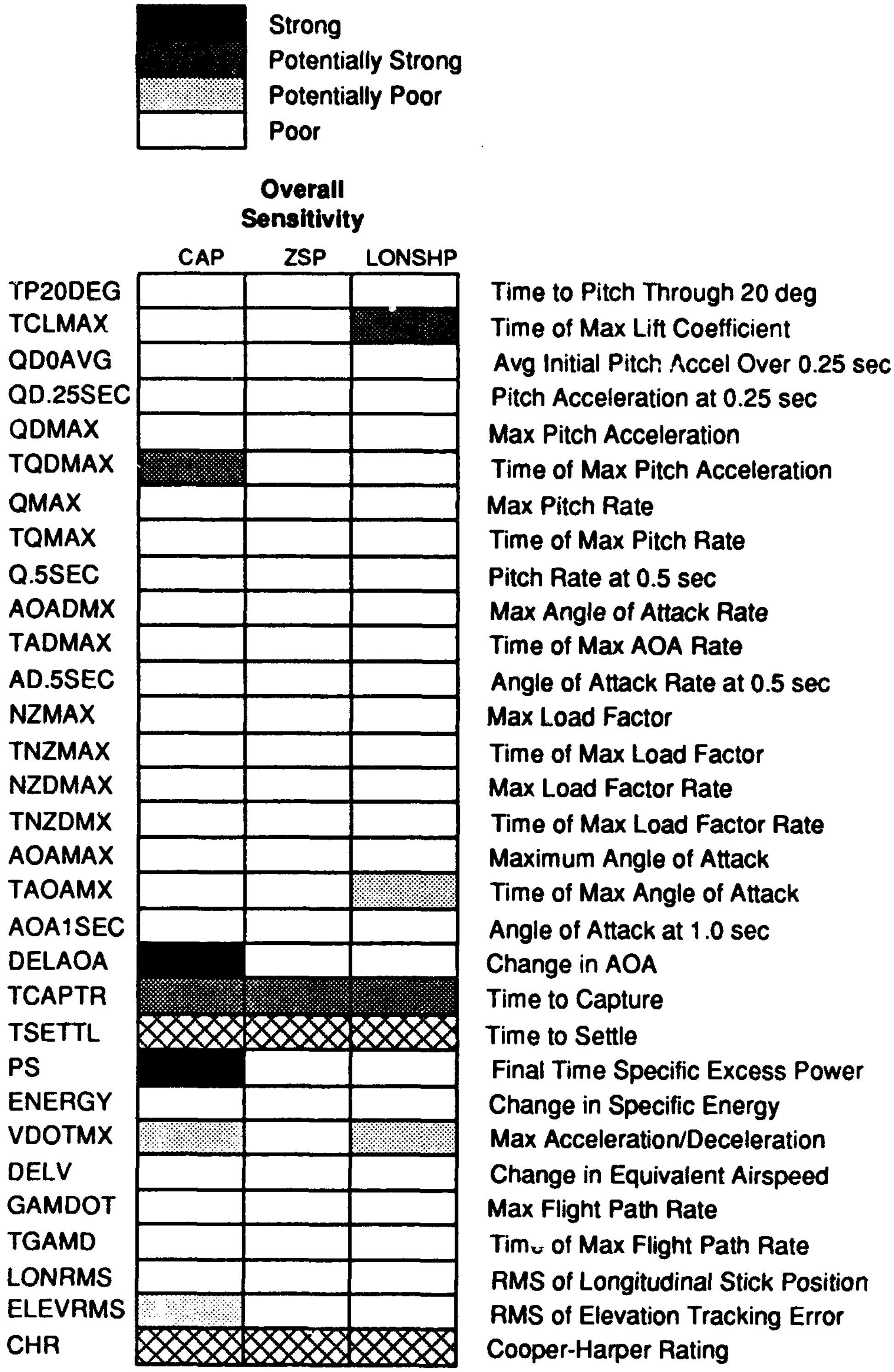
STEM 7 TEST 6


Strong
Potentially Strong
Potentially Poor
Poor
Sensitivity to Design Parameters
CAP
ZSP
LONSHP
TP20DEG
TCLMAX
QD0AVG
QD.25SEC
QDMAX
TQDMAX
QMAX
TQMAX
Q.5SEC
AOADMX
TADMAX
AD.5SEC
NZMAX
TNZMAX
NZDMAX
TNZDMX
AOAMAX
TAOAMX
AOA1SEC
DELAOA
TCAPTR
TSETTL
PS
ENERGY
VDOTMX
DELV
GAMDOT
TGAMD
LONRMS
ELEVRMS
CHR
Time to Pitch Through 20 deg
Time of Max Lift Coefficient
Avg Initial Pitch Accel Over 0.25 sec
Pitch Acceleration at 0.25 sec
Max Pitch Acceleration
Time of Max Pitch Acceleration
Max Pitch Rate
Time of Max Pitch Rate
Pitch Rate at 0.5 sec
Max Angle of Attack Rate
Time of Max AOA Rate
Angle of Attack Rate at 0.5 sec
Max Load Factor
Time of Max Load Factor
Max Load Factor Rate
Time of Max Load Factor Rate
Maximum Angle of Attack
Time of Max Angle of Attack
Angle of Attack at 1.0 sec
Change in AOA
Time to Capture
Time to Settle
Final Time Specific Excess Power
Change in Specific Energy
Max Acceleration/Deceleration
Change in Equivalent Airspeed
Max Flight Path Rate
Time of Max Flight Path Rate
RMS of Longitudinal Stick Position
RMS of Elevation Tracking Error
Cooper-Harper Rating

STEM 7 TEST 6


Minimal
Some
Large
Sensitivity to Pilot Variability
CAP
ZSP
LONSHP
TP20DEG
TCLMAX
QD0AVG
QD.25SEC
QDMAX
TQDMAX
QMAX
TQMAX
Q.5SEC
AOADMX
TADMAX
AD.5SEC
NZMAX
TNZMAX
NZDMAX
TNZDMX
AOAMAX
TAOAMX
AOA1SEC
DELAOA
TCAPTR
TSETTL
PS
ENERGY
VDOTMX
DELV
GAMDOT
TGAMD
LONRMS
ELEVRMS
CHR
Time to Pitch Through 20 deg
Time of Max Lift Coefficient
Avg Initial Pitch Accel Over 0.25 sec
Pitch Acceleration at 0.25 sec
Max Pitch Acceleration
Time of Max Pitch Acceleration
Max Pitch Rate
Time of Max Pitch Rate
Pitch Rate at 0.5 sec
Max Angle of Attack Rate
Time of Max AOA Rate
Angle of Attack Rate at 0.5 sec
Max Load Factor
Time of Max Load Factor
Max Load Factor Rate
Time of Max Load Factor Rate
Maximum Angle of Attack
Time of Max Angle of Attack
Angle of Attack at 1.0 sec
Change in AOA
Time to Capture
Time to Settle
Final Time Specific Excess Power
Change in Specific Energy
Max Acceleration/Deceleration
Change in Equivalent Airspeed
Max Flight Path Rate
Time of Max Flight Path Rate
RMS of Longitudinal Stick Position
RMS of Elevation Tracking Error
Cooper-Harper Rating

STEM 7 TEST 6



Strong
Potentially Strong
Potentially Poor
Poor
Overall Sensitivity
CAP
ZSP
LONSHP
TP20DEG
TCLMAX
QD0AVG
QD.25SEC
QDMAX
TQDMAX
QMAX
TQMAX
Q.5SEC
AOADMX
TADMAX
AD.5SEC
NZMAX
TNZMAX
NZDMAX
TNZDMX
AOAMAX
TAOAMX
AOA1SEC
DELAOA
TCAPTR
TSETTL
PS
ENERGY
VDOTMX
DELV
GAMDOT
TGAMD
LONRMS
ELEVRMS
CHR
Time to Pitch Through 20 deg
Time of Max Lift Coefficient
Avg Initial Pitch Accel Over 0.25 sec
Pitch Acceleration at 0.25 sec
Max Pitch Acceleration
Time of Max Pitch Acceleration
Max Pitch Rate
Time of Max Pitch Rate
Pitch Rate at 0.5 sec
Max Angle of Attack Rate
Time of Max AOA Rate
Angle of Attack Rate at 0.5 sec
Max Load Factor
Time of Max Load Factor
Max Load Factor Rate
Time of Max Load Factor Rate
Maximum Angle of Attack
Time of Max Angle of Attack
Angle of Attack at 1.0 sec
Change in AOA
Time to Capture
Time to Settle
Final Time Specific Excess Power
Change in Specific Energy
Max Acceleration/Deceleration
Change in Equivalent Airspeed
Max Flight Path Rate
Time of Max Flight Path Rate
RMS of Longitudinal Stick Position
RMS of Elevation Tracking Error
Cooper-Harper Rating

STEM 7 TEST 6
PILOT A
LONGITUDINAL CONFIGURATION 158
LATERAL CONFIGURATION 2
CHR 6
PIO 4

You have a lousy set of dynamics in here. Very unpredictable end game with this. It bobbles all over the place. I'm very lucky to hold it inside. My technique for doing this is I select throttle idle and put the nose down 15 degrees. I wait until I'm stabilized 15 degrees nose low. The velocity vector basically matches somewhere around 310 knots, plug in the blower, wait, and as I hit 340 I'm pulling up. On this airplane I can do a max pull right to the stop, the nose comes up, but then predicting where it is going to stop is almost impossible. The way that I did it that time was stopping a little bit short and then walking it in. Sometimes I can stop it right on, but after I've been on the target for two seconds it bounces out of my control. So even though the red light comes on it's basically useless. You could not count on getting it for an acquisition. Very unpredictable end game. What's unpredictable about it is how to release the stick forward so that you still keep it within the ±40 degrees. It's very easy to bounce out. So everything is good about it up until the point where I tend to capture at the end and then it falls to pieces. That's because of the predictability. Controllable? Yes. Adequate with a tolerable pilot work load? Yes, I could get that so we'll say yes. Is it satisfactory without improvement? No. I think to get desired performance you have to do it perfectly. I think it's a bad deficiency. I could get there quick enough. I was sacrificing capture time in order to try and smooth it out so I could guarantee it. But sometimes it would bobble out of there and it was all I could do to even hold adequate. So I am going to have to call it very objectionable but tolerable deficiencies and adequate requires extensive pilot compensation. It's a PIO problem. Pilot must reduce gain or abandon task -- that's the problem, I have to reduce gain. It's not divergent and it's not really an oscillation, it's an unpredictable motion. The rate though is good. The time to capture, if I could have got a capture, was good. The pitch rate was fine.

STEM 7 TEST 6
PILOT F
LONGITUDINAL CONFIGURATION 158
LATERAL CONFIGURATION 2

The onset rate is slower (than longitudinal configuration 101), but the capture is a lot more controllable. That time I trimmed the pitch up and it stopped on it, and when I let go I had a little PIO. So I have to trim it in and trim it out. It seems to be extremely sensitive to rapid changes in trim.

STEM 7 TEST 6
PILOT A
LONGITUDINAL CONFIGURATION 101
LATERAL CONFIGURATION 2
CHR 7
PIO 4

Who's designing this thing, Mr. Slinky? I get pitch racheting. Horrible handling qualities. I had to drop my gains down to nothing to see if I can do this. I have to lower my expectations. Even when I pulled up slowly I couldn't let off the stick without it bouncing out once. I think I am going to have to pull hard to get close and the accept the undershoot. It's almost divergent. How can I do this? Try max performing and see if that helps. See if it hits some sort of limit. Wouldn't that be a ride. This airplane would be unflyable. You would have to land hands off to keep from setting into a PIO. I'll try to do this hands off then. Get my nose up there, release the stick while I'm still out, there it is. I don't know how else to do it. This is such a bad configuration. That time I made desired criteria but with way too much workload and the PIO was objectionable. Is it controllable? Yes. Is adequate attainable with a tolerable pilot workload? No. Adequate performance sometimes was attainable. Those were not tolerable deficiencies. Control was not really in question, just trying to do anything with the airplane was. That was very, very poor. It was a big surprise every time to see what the nose was going to do. I could never get it to settle down. I don't know how you'd fly this airplane around. You basically have to use auto pilot to fly it. PIO rating: Well, I don't really think it was going to come out of the sky, but it was close. The pilot must reduce gain or abandon task to recover -- that's the situation there. It's refreshing to see such a poor set of handling qualities in a simulator. That's what these are for, but I hated it.

STEM 7 TEST 6
PILOT F
LONGITUDINAL CONFIGURATION 101
LATERAL CONFIGURATION 2

I'd say you'd have trouble shooting a missile on this airplane. This is a two-fingered one. There's a sort of a bobbling tracking motion after a little PIO. This is, as they say, unsatisfactory. The tracking is a problem. Even if I try to slow down the pitch rate, it doesn't seem to help the acquisition problem that much. The best way to fly it seems to be with a big gross input to get the nose going up fast, because once you get up there you're going to have to hunt around him. So just go from a full aft stick snap into a two-fingered hold when you get near him, because trying to slow the rate down doesn't solve the tracking. The tracking problem is the same on top whether you get there fast or slow. This onset rate is tremendously fast and the tracking problem is very difficult. I've got an extreme pitch sensitivity. Nice onset rate. Very difficult to control in fine tracking, actually even in the gross acquisition.

STEM 7 TEST 6
PILOT A
LONGITUDINAL CONFIGURATION 102
LATERAL CONFIGURATION 2
CHR 4
PIO 2

This one feels like an airplane, not a jack-in-the-box. Stops where you point it. Significant improvement. I was trying to max rate it a little bit too much and I had a little amount of pitch PIO. You can't expect to go from full aft stick to a dead stop and have it stop predictably. It's not the way to fly airplanes. Sometimes you get that way in the sim but it's not the way to fly. Let's fly it realistically. A little bit of a PIO tendency at the end. It takes some attention, but not bad. I'm using almost full aft stick. Pretty reasonable rate. The nose could be maybe a hair faster but not much. There's that PIO tendency if I try and rush it. I can damp out the PIO by being careful though. I would prefer if the final rate was a little quicker. It is controllable, and adequate performance is attainable. Is it satisfactory without improvement? No. It's a 4 because I can make my desired performance, but I'm giving up two things. My pitch rate seems a little bit slow. I can drive it a little bit faster, but then I miss my desired performance at the end. So I have to compensate for the end game by lowering my pitch rate. And the second part is the problems in the end game. If I come into it too fast and attempt to hurry to a pitch capture, I end up in a PIO that drives me out of desired criteria. So I have to work at it, and be careful to release the aft stick to neutral without driving it into a new PIO. So it's annoying deficiency. It's minor, but it's annoying and it requires moderate pilot compensation to sort out. PIO rating. Undesirable motions tend to occur. These motions can be prevented or eliminated by pilot technique. And if I didn't have these, the airplane would be a lot better, because otherwise it handles pretty well. And the pitch rate is too slow.

STEM 7 TEST 6
PILOT F
LONGITUDINAL CONFIGURATION 102
LATERAL CONFIGURATION 2

That's a distinct difference in capture compared to the other one (longitudinal configuration 126). The capture is a lot damped. That's not too bad. It's still pretty goosey at the top but I'm able to capture within the circle without having to do a whole lot of work in here on the stick. It's certainly not optimum but it's better than the previous one. The onset rate is just a tad slower, but it is very controllable. It is a little sensitive. You got to be careful on top to avoid any extra inputs. It seems to come up and stop on the target. But once it gets there and I touch the stick, it starts an oscillation. Anytime I put an input in, though, it started bobbling in the pitch.

STEM 7 TEST 6
PILOT A
LONGITUDINAL CONFIGURATION 126
LATERAL CONFIGURATION 2
CHR 4
PIO 2

This one is quite similar to the previous one (longitudinal configuration 102). I feel like I'm pitch rate limited a little bit too much, and I feel like the pitch sensitivity is a little too high at the end. I tried to drive it faster, leave in the stick right up until the end and it ended up bouncing out once. The pitch rate was a little bit too slow. I have to pay close attention at the end and be very careful what I do with the stick to keep it from bouncing up. The time is not bad. I which it would pitch just a little quicker and I wish the stick was slightly more predictable at the end. Those are my two complaints. I'm easing the stick from the far aft position to a more neutral position because I'm tracking the target in the middle of my circle. And what feels like a nice smooth release of the stick to me manifests itself as quite a bobbly pitch solution and I have to be perfectly smooth to get a perfectly smooth nose response. It's a little too sensitive. Is it controllable? Yes. Is adequate performance attainable? Yes. Is it satisfactory without improvement? No. It's virtually the same as last time. The two deficiencies are annoying. The pitch rate is too slow. The initial onset of acceleration is good, but then there just seems to cap at a rate that makes me a little bit impatient. But if I hold the stick fully aft the whole time, then I drive myself in the end into the other problem; lack of pitch predictability in my capture, which then drives me to cause PIO that threatens to bounce me out of desired criteria. So I have to be careful in both of those. I have to monitor my pitch rate and I have to modify my stick release at the end. The PIO is similar to the last time. If I'm really careful, I can eliminate the PIO tendencies, but generally I just kind of minimize it to stay within the tolerances by being careful of what I do with the stick.

STEM 7 TEST 6
PILOT F
LONGITUDINAL CONFIGURATION 126
LATERAL CONFIGURATION 2

It came up there real nice. I had a little problem stopping it at the top. It's a real nice predictable pull. But when I reached the target that time, I didn't stop the onset rate. So it looks like I'm going to start compensating right now, back off probably about 10 degrees ahead of time. That time I backed off about 10 degrees ahead of time, stopped below it, then pumped it, and overshot over the top of it. So I did a sort of an undershoot with an over correction. Onset rate still feels real smooth, though. It's just I can't seem to find the stabilization point. I don't have any trouble with pitch control down here in the bottom maintaining the attitude. It's just right at the top. I'm having a little bit of a bobble.

## Summary of Design Parameters Tested for STEM 7 TEST 7

Test variables:

CAP: Indicates a variation in $\omega_{sp}$ since this is a low speed flight condition. $\omega_{sp}$ scheduled linearly with knots equivalent airspeed (KEAS) with the following value at 100 KEAS:
- (-) 0.729 rad/sec, Level 1/2 boundary for high AOA acquisition from MCAIR research
- (+) 1.067 rad/sec, Solid Level 1 value for high AOA acquisition from MCAIR research

ZSP: A schedule of ZSP was implemented based on AOA:

For low AOA (≤10°), ZSP maintained at:
- (-) 0.35, Level 1/2 boundary from MIL-STD-1797A
- (+) 0.70, Within the Level 1 region from MIL-STD-1797A and generally good for acquisition

For high AOA (30°), ZSP maintained at:
- (-) 0.6, Level 1/2 boundary for high AOA maneuvering from MCAIR research
- (+) 1.2, Solid Level 1 value for high AOA maneuvering from MCAIR research

LONSNS: Indicates longitudinal stick sensitivity. This also affects maximum AOA:
- (-) 9.0°/in, Acceptable level of sensitivity but potentially borderline high.
- (+) 12.0°/in, High sensitivity.

TIMDEL: Indicates the amount of pure time delay added in the simulation. This is in addition to the inherent computational and visual scene update delays
- (-) 0, No additional time delay beyond the ≈100 msec due to the simulation setup.
- (+) 67 msec, Results in approximately 167 msec of time delay (Level 2).

LONSHP: Indicates whether or not non-linear stick shaping is being used:
- (-) No shaping, longitudinal dynamics do not vary with stick position
- (+) Shaping, $\omega_{sp}$ reduced and $\zeta_{sp}$ increased for for small incremental stick inputs

### Configurations Tested

| Lon Config | Lat Config | CAP | ZSP | LONSNS | TIMDEL | LONSHP |
|---|---|---|---|---|---|---|
| 131 | 2 | 0.729 (-) | 0.35/0.6 (-) | 9.0 (-) | 0 (-) | Off (-) |
| 132 | 2 | 1.067 (+) | 0.35/0.6 (-) | 9.0 (-) | 67 (+) | Off (-) |
| 133 | 2 | 0.729 (-) | 0.70/1.2 (+) | 9.0 (-) | 67 (+) | Off (-) |
| 134 | 2 | 1.067 (+) | 0.70/1.2 (+) | 9.0 (-) | 0 (-) | Off (-) |
| 135 | 2 | 0.729 (-) | 0.35/0.6 (-) | 12.0 (+) | 67 (+) | Off (-) |
| 136 | 2 | 1.067 (+) | 0.35/0.6 (-) | 12.0 (+) | 0 (-) | Off (-) |
| 137 | 2 | 0.729 (-) | 0.7/1.2 (+) | 12.0 (+) | 0 (-) | Off (-) |
| 138 | 2 | 1.067 (+) | 0.7/1.2 (+) | 12.0 (+) | 67 (+) | Off (-) |
| 139 | 2 | 1.067 (+) | 0.35/0.6 (-) | 12.0 (+) | 0 (-) | On (+) |
| 176 | 2 | 0.729 (-) | 0.35/0.6 (-) | 12.0 (+) | 0 (-) | Off (-) |
| 177 | 2 | 1.067 (+) | 0.35/0.6 (-) | 9.0 (-) | 0 (-) | Off (-) |
| 178 | 2 | 0.729 (-) | 0.70/1.2 (+) | 9.0 (-) | 0 (-) | Off (-) |
| 179 | 2 | 1.067 (+) | 0.7/1.2 (+) | 12.0 (+) | 0 (-) | Off (-) |

Note: Pilot E and pilot G data available for all test points.
Pilot A and pilot F data only available for lon configurations: 131, 134, 136, 137, 139, 176, 177, 178, and 179.

## Summary of Design Parameters Tested for STEM 7 TEST 7

### Test Matrix for Analysis A (Pilots E,G for all test points, Pilots A,F for half)

| Lon Config | Lat Config | CAP | ZSP | LONSNS | TIMDEL | LONSHP |
|---|---|---|---|---|---|---|
| 131 | 2 | 0.729 (-) | 0.35/0.6 (-) | 9.0 (-) | 0 (-) | Off (-) |
| 132 | 2 | 1.067 (+) | 0.35/0.6 (-) | 9.0 (-) | 67 (+) | Off (-) |
| 133 | 2 | 0.729 (-) | 0.70/1.2 (+) | 9.0 (-) | 67 (+) | Off (-) |
| 134 | 2 | 1.067 (+) | 0.70/1.2 (+) | 9.0 (-) | 0 (-) | Off (-) |
| 135 | 2 | 0.729 (-) | 0.35/0.6 (-) | 12.0 (+) | 67 (+) | Off (-) |
| 136 | 2 | 1.067 (+) | 0.35/0.6 (-) | 12.0 (+) | 0 (-) | Off (-) |
| 137 | 2 | 0.729 (-) | 0.7/1.2 (+) | 12.0 (+) | 0 (-) | Off (-) |
| 138 | 2 | 1.067 (+) | 0.7/1.2 (+) | 12.0 (+) | 67 (+) | Off (-) |

### Test Matrix for Analysis B (Full Factorial, Pilots A,E,F,G)

| Lon Config | Lat Config | CAP | ZSP | LONSNS |
|---|---|---|---|---|
| 176 | 2 | 0.729 (-) | 0.35/0.6 (-) | 12.0 (+) |
| 177 | 2 | 1.067 (+) | 0.35/0.6 (-) | 9.0 (-) |
| 178 | 2 | 0.729 (-) | 0.70/1.2 (+) | 9.0 (-) |
| 179 | 2 | 1.067 (+) | 0.7/1.2 (+) | 12.0 (+) |
| 131 | 2 | 0.729 (-) | 0.35/0.6 (-) | 9.0 (-) |
| 136 | 2 | 1.067 (+) | 0.35/0.6 (-) | 12.0 (+) |
| 137 | 2 | 0.729 (-) | 0.7/1.2 (+) | 12.0 (+) |
| 134 | 2 | 1.067 (+) | 0.70/1.2 (+) | 9.0 (-) |

### Test Matrix for Analysis C (Pilots A,E,F,G)

| Lon Config | Lat Config | LONSHP |
|---|---|---|
| 136 | 2 | Off (-) |
| 139 | 2 | On (+) |

### Test Matrix for Analysis D (Pilots E,G)

| Lon Config | Lat Config | CAP | ZSP | LONSNS | TIMDEL | LONSHP |
|---|---|---|---|---|---|---|
| 131 | 2 | 0.729 (-) | 0.35/0.6 (-) | 9.0 (-) | 0 (-) | Off (-) |
| 132 | 2 | 1.067 (+) | 0.35/0.6 (-) | 9.0 (-) | 67 (+) | Off (-) |
| 133 | 2 | 0.729 (-) | 0.70/1.2 (+) | 9.0 (-) | 67 (+) | Off (-) |
| 134 | 2 | 1.067 (+) | 0.70/1.2 (+) | 9.0 (-) | 0 (-) | Off (-) |
| 135 | 2 | 0.729 (-) | 0.35/0.6 (-) | 12.0 (+) | 67 (+) | Off (-) |
| 136 | 2 | 1.067 (+) | 0.35/0.6 (-) | 12.0 (+) | 0 (-) | Off (-) |
| 137 | 2 | 0.729 (-) | 0.7/1.2 (+) | 12.0 (+) | 0 (-) | Off (-) |
| 138 | 2 | 1.067 (+) | 0.7/1.2 (+) | 12.0 (+) | 67 (+) | Off (-) |

## Summary of Design Parameters Tested for STEM 7 TEST 7

### Test Matrix for Analysis E (Pilots A,E,F,G)

| Lon Config | Lat Config | CAP | ZSP | LONSNS |
|---|---|---|---|---|
| 176 | 2 | 0.729 (-) | 0.35/0.6 (-) | 12.0 (+) |
| 177 | 2 | 1.067 (+) | 0.35/0.6 (-) | 9.0 (-) |
| 178 | 2 | 0.729 (-) | 0.70/1.2 (+) | 9.0 (-) |
| 179 | 2 | 1.067 (+) | 0.7/1.2 (+) | 12.0 (+) |

### Test Matrix for Analysis F (Pilots A,E,F,G)

| Lon Config | Lat Config | CAP | ZSP | LONSNS |
|---|---|---|---|---|
| 131 | 2 | 0.729 (-) | 0.35/0.6 (-) | 9.0 (-) |
| 136 | 2 | 1.067 (+) | 0.35/0.6 (-) | 12.0 (+) |
| 137 | 2 | 0.729 (-) | 0.7/1.2 (+) | 12.0 (+) |
| 134 | 2 | 1.067 (+) | 0.70/1.2 (+) | 9.0 (-) |

### Test Matrix for Analysis G (Full Factorial, Pilots A,E,F,G)
### (Pilots A, G are test pilots, pilots E, F are operational)

| Lon Config | Lat Config | CAP | ZSP | LONSNS |
|---|---|---|---|---|
| 176 | 2 | 0.729 (-) | 0.35/0.6 (-) | 12.0 (+) |
| 177 | 2 | 1.067 (+) | 0.35/0.6 (-) | 9.0 (-) |
| 178 | 2 | 0.729 (-) | 0.70/1.2 (+) | 9.0 (-) |
| 179 | 2 | 1.067 (+) | 0.7/1.2 (+) | 12.0 (+) |
| 131 | 2 | 0.729 (-) | 0.35/0.6 (-) | 9.0 (-) |
| 136 | 2 | 1.067 (+) | 0.35/0.6 (-) | 12.0 (+) |
| 137 | 2 | 0.729 (-) | 0.7/1.2 (+) | 12.0 (+) |
| 134 | 2 | 1.067 (+) | 0.70/1.2 (+) | 9.0 (-) |

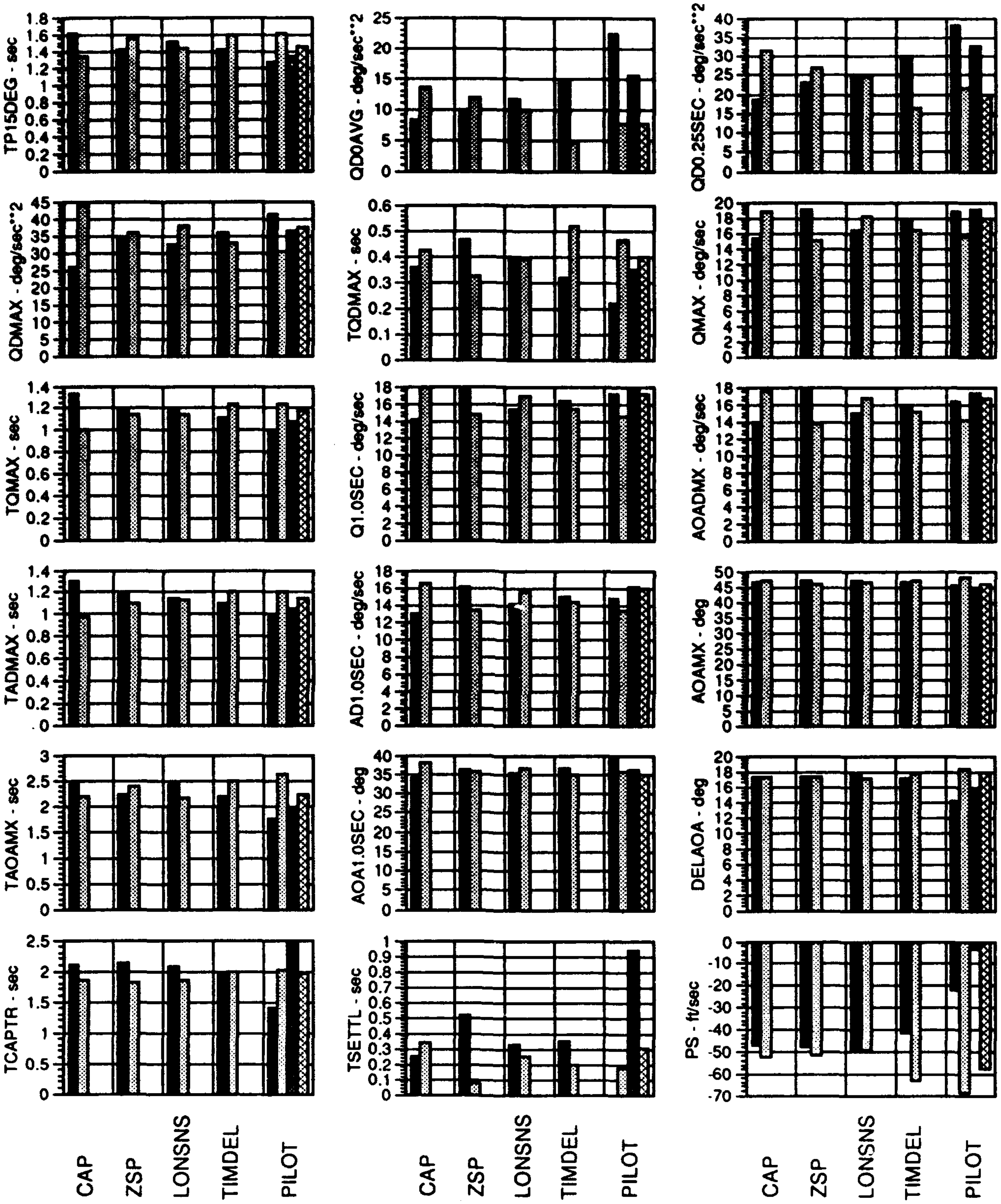
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | TPXDEG | 0.9999 | CAP | 1.000 | 1.6209 | 1.3365 | 0 | 0 | -0.194 | 0.84 | 3 | 3 | 4 |
| | (15 deg) | | ZSP | 1.000 | 1.4076 | 1.5499 | 0 | 0 | 0.096 | 0.42 | 4 | 3 | 4 |
| | | | LONSNS | 1.000 | 1.5135 | 1.4345 | 0 | 0 | -0.054 | 0.23 | 4 | 3 | 4 |
| | | | TIMDEL | 1.000 | 1.4112 | 1.5941 | 0 | 0 | 0.122 | 0.53 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 1.2754 | 1.6042 | 1.3394 | 1.4619 | 0.231 | | | | |
| 4 | QD0AVG | 0.9999 | CAP | 1.000 | 8.0953 | 13.6 | 0 | 0 | 0.542 | 0.42 | 1 | 3 | 3 |
| | (0.25 sec) | | ZSP | 0.971 | 9.9285 | 11.766 | 0 | 0 | 0.171 | 0.13 | 3 | 3 | 4 |
| | | | LONSNS | 0.886 | 11.556 | 9.9473 | 0 | 0 | -0.150 | 0.12 | 4 | 3 | 4 |
| | | | TIMDEL | 1.000 | 14.491 | 4.6173 | 0 | 0 | -1.410 | 1.08 | 1 | 2 | 2 |
| | | | PLT | 1.000 | 22.302 | 7.5741 | 15.563 | 7.6727 | -1.302 | | | | |
| 5 | QDXSEC | 0.9999 | CAP | 1.000 | 18.632 | 31.51 | 0 | 0 | 0.550 | 0.93 | 1 | 3 | 3 |
| | (0.25 sec) | | ZSP | 0.997 | 23.029 | 27.113 | 0 | 0 | 0.164 | 0.28 | 3 | 3 | 4 |
| | | | LONSNS | 0.148 | 25.285 | 24.799 | 0 | 0 | -0.019 | 0.03 | 4 | 3 | 4 |
| | | | TIMDEL | 1.000 | 30.222 | 16.264 | 0 | 0 | -0.660 | 1.11 | 1 | 2 | 2 |
| | | | PLT | 1.000 | 38.054 | 21.666 | 32.598 | 19.922 | -0.593 | | | | |
| 6 | QDMAX | 0.9999 | CAP | 1.000 | 25.878 | 43.723 | 0 | 0 | 0.549 | 1.71 | 1 | 2 | 2 |
| | | | ZSP | 1.000 | 33.724 | 35.877 | 0 | 0 | 0.062 | 0.19 | 4 | 3 | 4 |
| | | | LONSNS | 1.000 | 32.489 | 37.737 | 0 | 0 | 0.150 | 0.47 | 3 | 3 | 4 |
| | | | TIMDEL | 1.000 | 35.994 | 32.76 | 0 | 0 | -0.094 | 0.29 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 41.479 | 30.272 | 36.257 | 37.526 | -0.320 | | | | |
| 7 | TQDMAX | 0.7624 | CAP | 0.710 | 0.3602 | 0.4246 | 0 | 0 | 0.165 | 0.20 | 4 | 3 | 4 |
| | | | ZSP | 0.973 | 0.4623 | 0.3225 | 0 | 0 | -0.368 | 0.45 | 2 | 3 | 4 |
| | | | LONSNS | 0.030 | 0.3955 | 0.3885 | 0 | 0 | -0.018 | 0.02 | 4 | 3 | 4 |
| | | | TIMDEL | 0.997 | 0.3206 | 0.515 | 0 | 0 | 0.492 | 0.59 | 1 | 3 | 3 |
| | | | PLT | 0.558 | 0.217 | 0.461 | 0.3519 | 0.3973 | 0.827 | | | | |
| 8 | QMAX | 0.9999 | CAP | 1.000 | 15.344 | 18.889 | 0 | 0 | 0.209 | 1.05 | 2 | 2 | 3 |
| | | | ZSP | 1.000 | 19.13 | 15.104 | 0 | 0 | -0.238 | 1.20 | 2 | 2 | 3 |
| | | | LONSNS | 1.000 | 16.254 | 18.212 | 0 | 0 | 0.114 | 0.57 | 3 | 3 | 4 |
| | | | TIMDEL | 1.000 | 17.538 | 16.397 | 0 | 0 | -0.067 | 0.34 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 18.75 | 15.394 | 18.955 | 17.965 | -0.199 | | | | |
| 9 | TQMAX | 0.9999 | CAP | 1.000 | 1.3305 | 0.9996 | 0 | 0 | -0.290 | 1.42 | 2 | 2 | 3 |
| | | | ZSP | 0.997 | 1.1861 | 1.1439 | 0 | 0 | -0.036 | 0.18 | 4 | 3 | 4 |
| | | | LONSNS | 0.911 | 1.1763 | 1.1507 | 0 | 0 | -0.022 | 0.11 | 4 | 3 | 4 |
| | | | TIMDEL | 1.000 | 1.1216 | 1.2393 | 0 | 0 | 0.100 | 0.49 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 1.0087 | 1.2361 | 1.0769 | 1.1806 | 0.205 | | | | |
| 10 | QXSEC | 0.9999 | CAP | 1.000 | 14.182 | 17.879 | 0 | 0 | 0.234 | 1.40 | 2 | 2 | 3 |
| | (1.0 sec) | | ZSP | 1.000 | 17.433 | 14.627 | 0 | 0 | -0.176 | 1.06 | 3 | 2 | 4 |
| | | | LONSNS | 1.000 | 15.37 | 16.87 | 0 | 0 | 0.093 | 0.56 | 4 | 3 | 4 |
| | | | TIMDEL | 0.999 | 16.412 | 15.378 | 0 | 0 | -0.065 | 0.39 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 17.034 | 14.433 | 17.666 | 17.106 | -0.166 | | | | |
| 11 | AOADMX | 0.9999 | CAP | 1.000 | 13.861 | 17.455 | 0 | 0 | 0.233 | 1.54 | 2 | 2 | 3 |
| | | | ZSP | 1.000 | 17.608 | 13.708 | 0 | 0 | -0.253 | 1.68 | 2 | 2 | 3 |
| | | | LONSNS | 1.000 | 14.825 | 16.716 | 0 | 0 | 0.120 | 0.80 | 3 | 3 | 4 |
| | | | TIMDEL | 1.000 | 15.939 | 15.177 | 0 | 0 | -0.049 | 0.32 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 16.404 | 14.114 | 17.319 | 16.77 | -0.151 | | | | |
| 12 | TADMAX | 0.9999 | CAP | 1.000 | 1.2935 | 0.977 | 0 | 0 | -0.284 | 1.30 | 2 | 2 | 3 |
| | | | ZSP | 1.000 | 1.1742 | 1.0963 | 0 | 0 | -0.069 | 0.32 | 4 | 3 | 4 |
| | | | LONSNS | 0.766 | 1.1423 | 1.1264 | 0 | 0 | -0.014 | 0.06 | 4 | 3 | 4 |
| | | | TIMDEL | 1.000 | 1.0924 | 1.2086 | 0 | 0 | 0.101 | 0.46 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 0.9754 | 1.2111 | 1.0519 | 1.1431 | 0.218 | | | | |
| 13 | ADXSEC | 0.9999 | CAP | 1.000 | 12.939 | 16.433 | 0 | 0 | 0.241 | 2.35 | 2 | 1 | 2 |
| | (1.0 sec) | | ZSP | 1.000 | 16.083 | 13.289 | 0 | 0 | -0.192 | 1.87 | 3 | 2 | 4 |
| | | | LONSNS | 1.000 | 14.051 | 15.492 | 0 | 0 | 0.098 | 0.95 | 4 | 3 | 4 |
| | | | TIMDEL | 0.968 | 14.916 | 14.293 | 0 | 0 | -0.043 | 0.42 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 14.731 | 13.297 | 16.132 | 16.024 | -0.103 | | | | |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | AOAMX | 0.9999 | CAP | 0.700 | 46.505 | 46.838 | 0 | 0 | 0.007 | 0.12 | 4 | 3 | 4 |
| | | | ZSP | 1.000 | 47.267 | 46.077 | 0 | 0 | -0.026 | 0.44 | 4 | 3 | 4 |
| | | | LONSNS | 0.719 | 46.841 | 46.457 | 0 | 0 | -0.008 | 0.14 | 4 | 3 | 4 |
| | | | TIMDEL | 0.764 | 46.502 | 46.962 | 0 | 0 | 0.010 | 0.17 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 45.378 | 48.11 | 44.926 | 46.035 | 0.058 | | | | |
| 21 | TAOAMX | 0.9992 | CAP | 0.950 | 2.4055 | 2.1806 | 0 | 0 | -0.098 | 0.23 | 4 | 3 | 4 |
| | | | ZSP | 0.807 | 2.2136 | 2.3725 | 0 | 0 | 0.069 | 0.17 | 4 | 3 | 4 |
| | | | LONSNS | 0.983 | 2.4114 | 2.1427 | 0 | 0 | -0.118 | 0.28 | 3 | 3 | 4 |
| | | | TIMDEL | 0.981 | 2.1848 | 2.478 | 0 | 0 | 0.126 | 0.30 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 1.742 | 2.6223 | 1.9686 | 2.2369 | 0.420 | | | | |
| 22 | AOAXSEC | 0.9999 | CAP | 1.000 | 34.052 | 38.079 | 0 | 0 | 0.112 | 1.32 | 3 | 2 | 4 |
| | (1.0 sec) | | ZSP | 0.840 | 36.396 | 35.736 | 0 | 0 | -0.018 | 0.22 | 4 | 3 | 4 |
| | | | LONSNS | 1.000 | 35.55 | 36.721 | 0 | 0 | 0.032 | 0.38 | 4 | 3 | 4 |
| | | | TIMDEL | 1.000 | 36.766 | 34.869 | 0 | 0 | -0.053 | 0.63 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 38.845 | 35.697 | 36.452 | 35.036 | -0.085 | | | | |
| 23 | DELAOA | 0.9993 | CAP | 0.518 | 17.142 | 17.356 | 0 | 0 | 0.012 | 0.05 | 4 | 3 | 4 |
| | | | ZSP | 0.389 | 17.331 | 17.166 | 0 | 0 | -0.010 | 0.04 | 4 | 3 | 4 |
| | | | LONSNS | 0.906 | 17.481 | 16.954 | 0 | 0 | -0.031 | 0.12 | 4 | 3 | 4 |
| | | | TIMDEL | 0.984 | 16.945 | 17.769 | 0 | 0 | 0.047 | 0.18 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 14.16 | 18.325 | 15.796 | 17.905 | 0.261 | | | | |
| 25 | TCAPTR | 0.9996 | CAP | 0.923 | 2.0972 | 1.8591 | 0 | 0 | -0.121 | 0.33 | 3 | 3 | 4 |
| | | | ZSP | 0.977 | 2.1266 | 1.8297 | 0 | 0 | -0.151 | 0.41 | 3 | 3 | 4 |
| | | | LONSNS | 0.878 | 2.071 | 1.8602 | 0 | 0 | -0.108 | 0.30 | 4 | 3 | 4 |
| | | | TIMDEL | 0.082 | 1.966 | 1.999 | 0 | 0 | 0.017 | 0.05 | 4 | 3 | 4 |
| | | | PLT | 0.999 | 1.4129 | 2.0181 | 2.4769 | 1.9515 | 0.364 | | | | |
| 26 | TSETTL | 0.9998 | CAP | 0.490 | 0.2524 | 0.3381 | 0 | 0 | 0.297 | #DIV/0! | 4 | | 4 |
| | | | ZSP | 0.999 | 0.5155 | 0.075 | 0 | 0 | -3.363 | #DIV/0! | 1 | | 1 |
| | | | LONSNS | 0.400 | 0.3309 | 0.25 | 0 | 0 | -0.284 | #DIV/0! | 4 | | 4 |
| | | | TIMDEL | 0.804 | 0.3528 | 0.1968 | 0 | 0 | -0.618 | #DIV/0! | 2 | | 2 |
| | | | PLT | 0.998 | 0 | 0.1736 | 0.9375 | 0.3042 | 0.000 | | | | |
| 36 | PS | 0.9999 | CAP | 0.988 | -47.136 | -52.076 | 0 | 0 | -0.100 | 0.07 | 4 | 3 | 4 |
| | | | ZSP | 0.971 | -47.586 | -51.626 | 0 | 0 | -0.082 | 0.06 | 4 | 3 | 4 |
| | | | LONSNS | 0.050 | -49.562 | -49.662 | 0 | 0 | -0.002 | 0.00 | 4 | 3 | 4 |
| | | | TIMDEL | 1.000 | -41.737 | -63.059 | 0 | 0 | -0.425 | 0.31 | 1 | 3 | 3 |
| | | | PLT | 1.000 | -22.263 | -68.466 | -3.4285 | -58.076 | -1.375 | | | | |
| 37 | ENERGY | 0.9999 | CAP | 0.522 | -204.8 | -212.32 | 0 | 0 | -0.036 | 0.04 | 4 | 3 | 4 |
| | | | ZSP | 0.972 | -220.61 | -196.51 | 0 | 0 | 0.116 | 0.14 | 3 | 3 | 4 |
| | | | LONSNS | 0.921 | -217.24 | -197.54 | 0 | 0 | 0.095 | 0.11 | 4 | 3 | 4 |
| | | | TIMDEL | 0.997 | -195.5 | -230.89 | 0 | 0 | -0.167 | 0.20 | 3 | 3 | 4 |
| | | | PLT | 1.000 | -117.1 | -254.33 | -154.39 | -212.73 | -0.856 | | | | |
| 38 | VDOTMX | 0.9999 | CAP | 0.062 | -6.9627 | -6.974 | 0 | 0 | -0.002 | 0.01 | 4 | 3 | 4 |
| | | | ZSP | 0.996 | -7.1819 | -6.7548 | 0 | 0 | 0.061 | 0.25 | 4 | 3 | 4 |
| | | | LONSNS | 0.339 | -6.9447 | -6.9985 | 0 | 0 | -0.008 | 0.03 | 4 | 3 | 4 |
| | | | TIMDEL | 1.000 | -6.7298 | -7.3762 | 0 | 0 | -0.092 | 0.38 | 4 | 3 | 4 |
| | | | PLT | 1.000 | -5.8235 | -7.3909 | -6.0408 | -7.3708 | -0.241 | | | | |
| 39 | DELV | 0.9999 | CAP | 0.179 | -13.72 | -13.591 | 0 | 0 | 0.009 | 0.02 | 4 | 3 | 4 |
| | | | ZSP | 0.978 | -14.32 | -12.992 | 0 | 0 | 0.097 | 0.17 | 4 | 3 | 4 |
| | | | LONSNS | 0.966 | -14.215 | -12.946 | 0 | 0 | 0.094 | 0.16 | 4 | 3 | 4 |
| | | | TIMDEL | 0.991 | -13.023 | -14.739 | 0 | 0 | -0.124 | 0.21 | 3 | 3 | 4 |
| | | | PLT | 1.000 | -8.5857 | -14.906 | -12.939 | -14.675 | -0.580 | | | | |
| 42 | LONRMS | 0.9999 | CAP | 0.999 | 1.2254 | 0.9719 | 0 | 0 | -0.234 | 0.86 | 2 | 3 | 4 |
| | | | ZSP | 0.967 | 1.1736 | 1.0237 | 0 | 0 | -0.137 | 0.51 | 3 | 3 | 4 |
| | | | LONSNS | 0.173 | 1.1048 | 1.0908 | 0 | 0 | -0.013 | 0.05 | 4 | 3 | 4 |
| | | | TIMDEL | 0.957 | 1.0405 | 1.198 | 0 | 0 | 0.141 | 0.52 | 3 | 3 | 4 |
| | | | PLT | 0.967 | 0.8724 | 1.1404 | 0.9178 | 1.2396 | 0.271 | | | | |

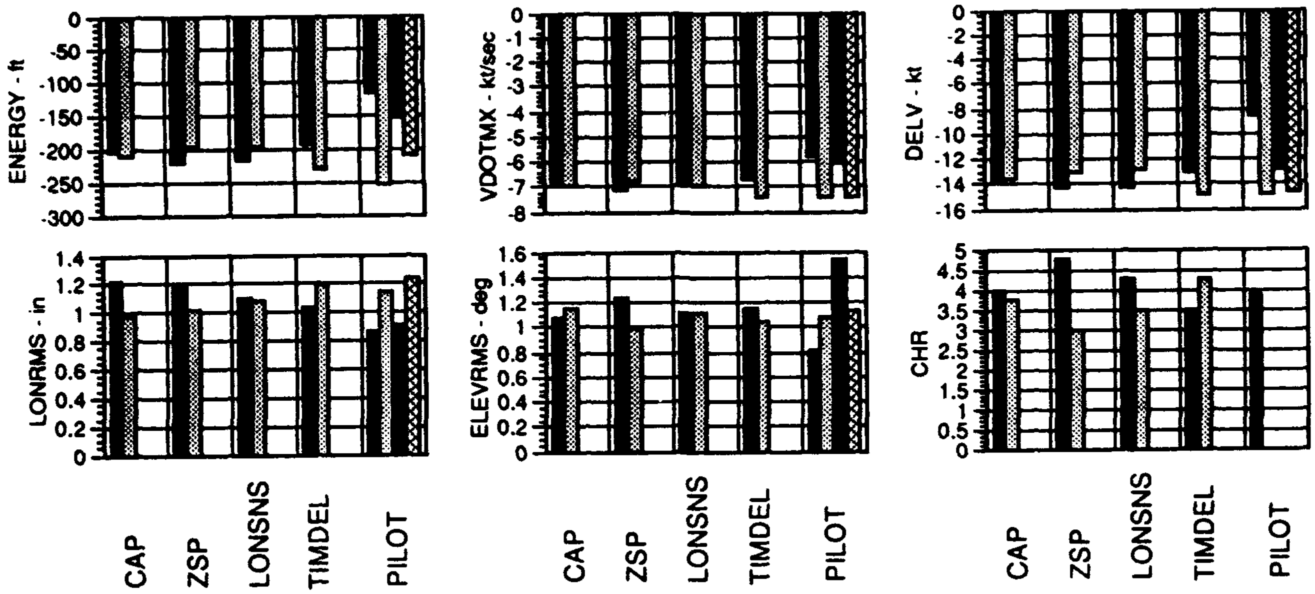
STEM 7 TEST 7 ANALYSIS A

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 44 | ELEVRMS | 0.9979 | CAP | 0.554 | 1.0842 | 1.1486 | 0 | 0 | 0.058 | 0.20 | 4 | 3 | 4 |
| | | | ZSP | 0.996 | 1.2416 | 0.9912 | 0 | 0 | -0.227 | 0.81 | 2 | 3 | 4 |
| | | | LONSNS | 0.087 | 1.1155 | 1.1175 | 0 | 0 | 0.002 | 0.01 | 4 | 3 | 4 |
| | | | TIMDEL | 0.806 | 1.1559 | 1.0489 | 0 | 0 | -0.097 | 0.35 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 0.812 | 1.0723 | 1.5382 | 1.1239 | 0.282 | | | | |
| 49 | CHR | 0 | CAP | -999.000 | 4 | 3.75 | 0 | 0 | -0.065 | 0.00 | 4 | 3 | 4 |
| | | | ZSP | -999.000 | 4.75 | 3 | 0 | 0 | -0.476 | 0.00 | 4 | 3 | 4 |
| | | | LONSNS | -999.000 | 4.25 | 3.5 | 0 | 0 | -0.195 | 0.00 | 4 | 3 | 4 |
| | | | TIMDEL | -999.000 | 3.5 | 4.25 | 0 | 0 | 0.195 | 0.00 | 4 | 3 | 4 |
| | | | PLT | -999.000 | 3.875 | -999 | -999 | -999 | -129.905 | | | | |

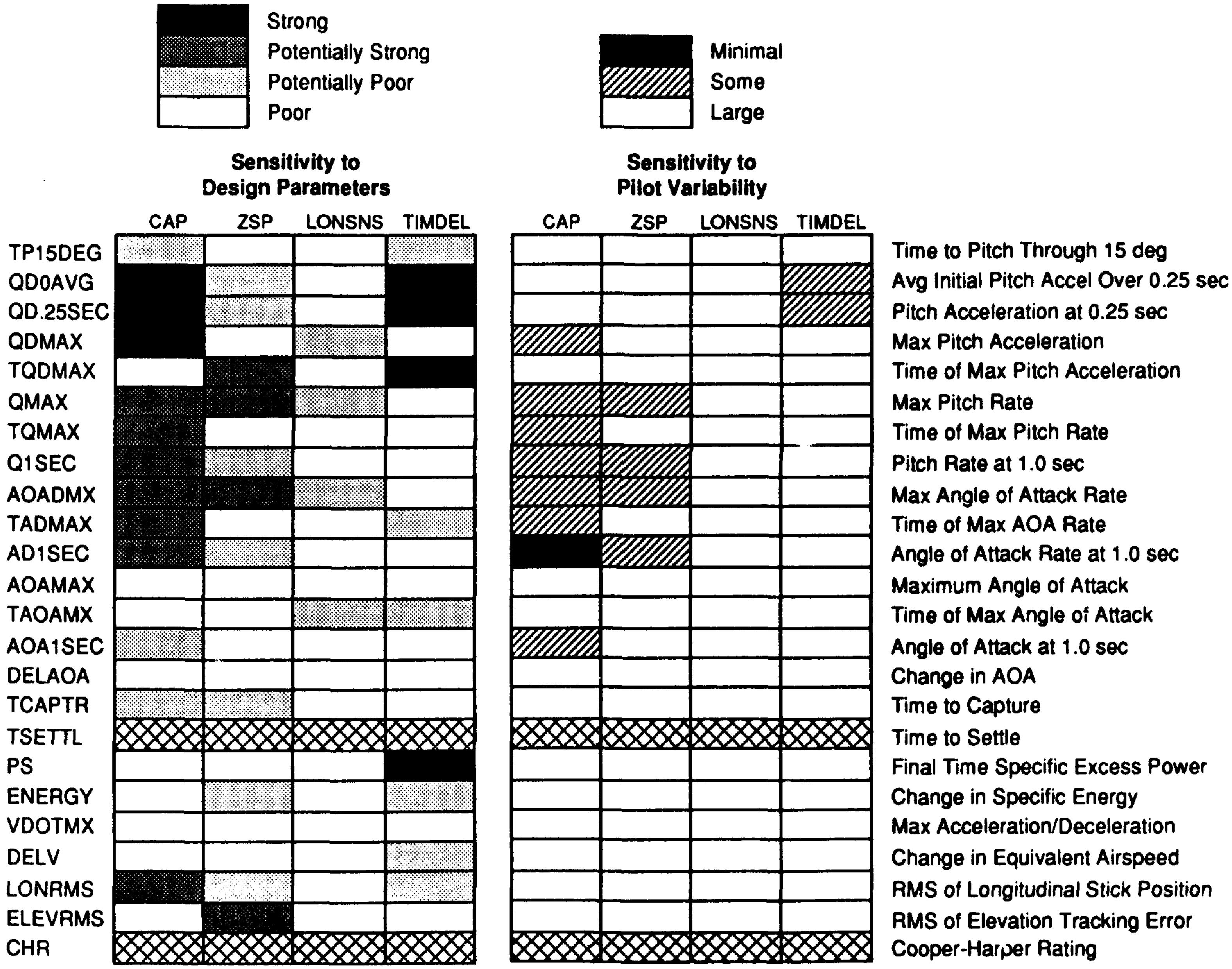
STEM 7 TEST 7 ANALYSIS A

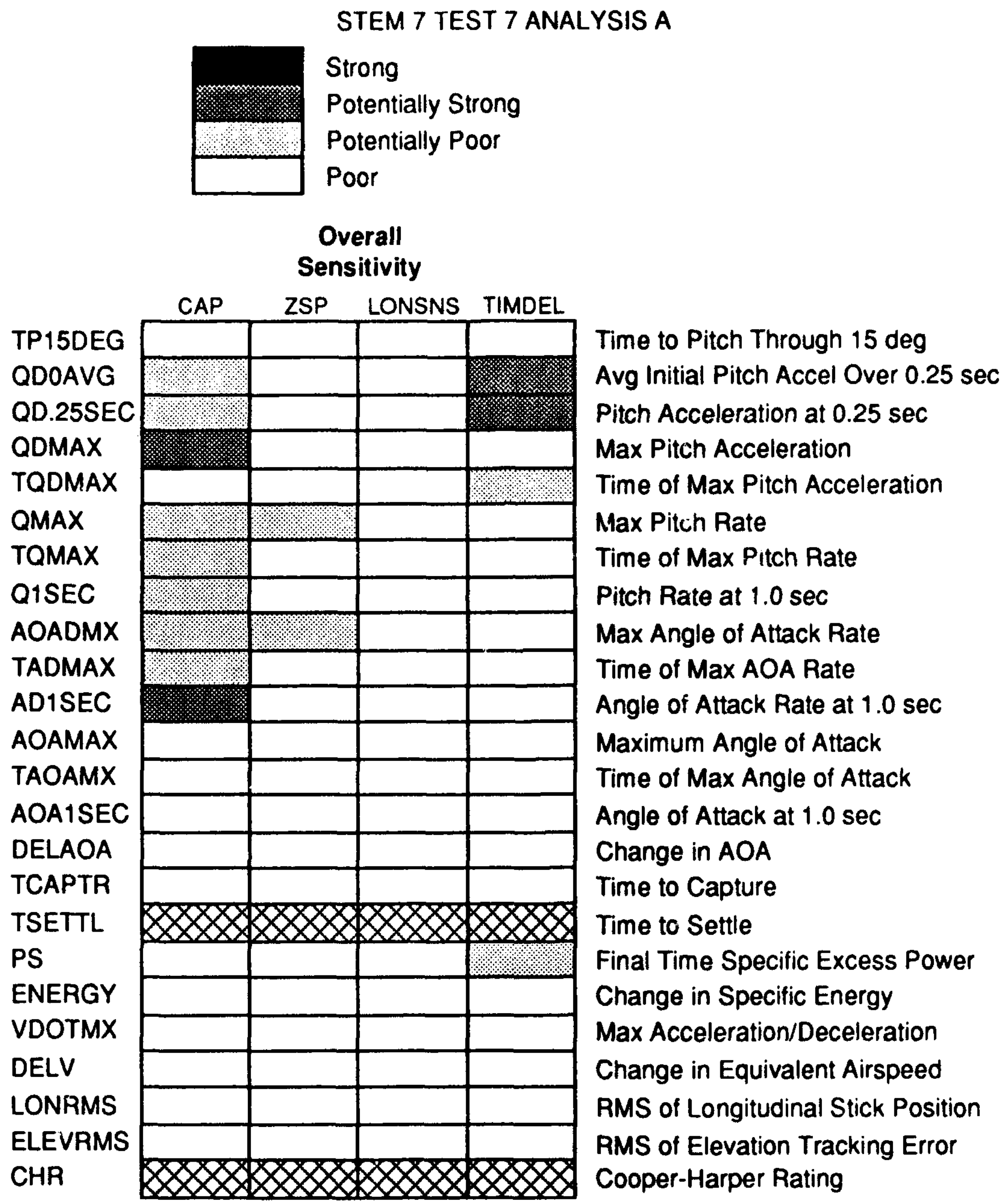


STEM 7 TEST 7 ANALYSIS A



STEM 7 TEST 7 ANALYSIS A

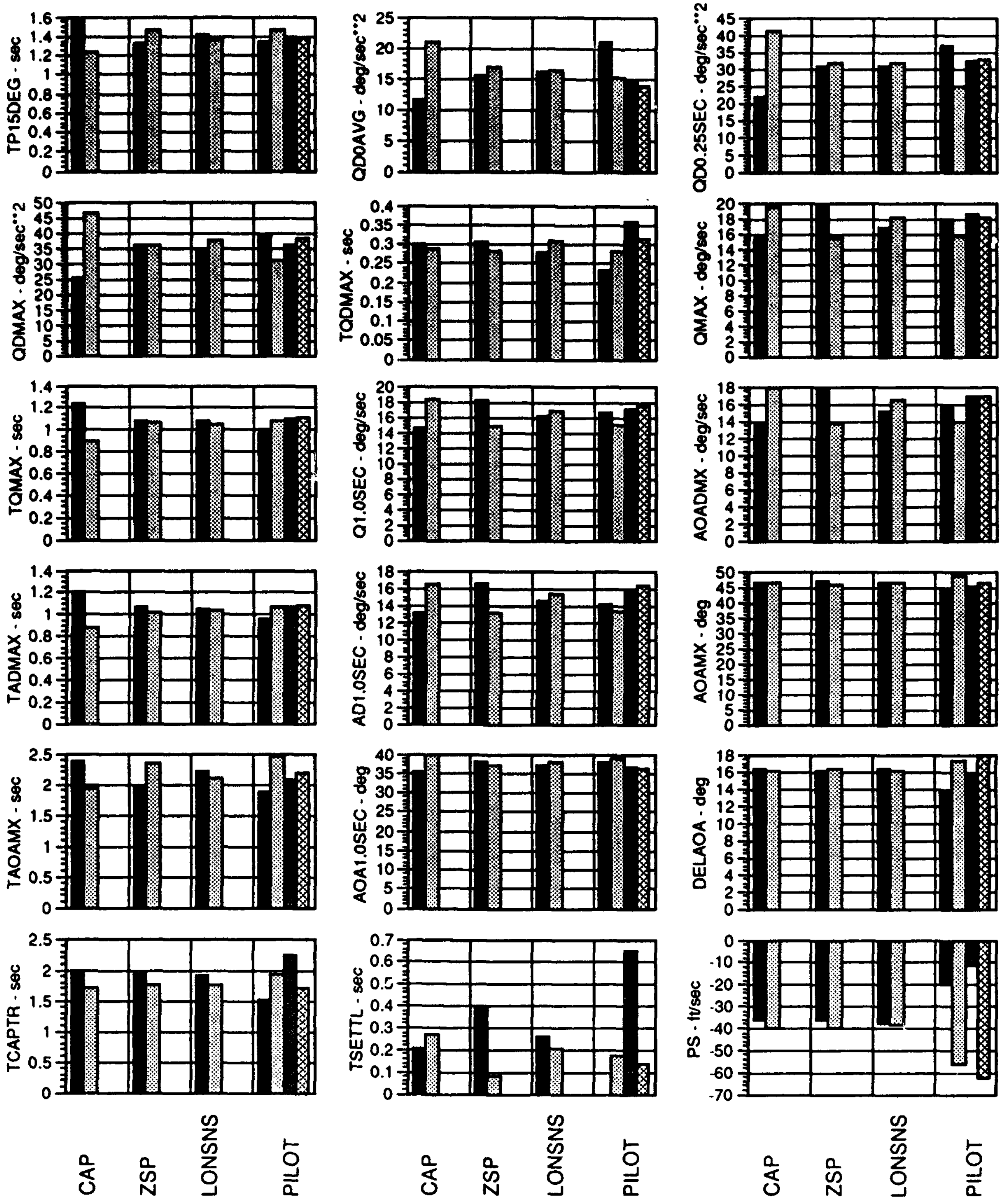



STEM 7 TEST 7 ANALYSIS A
Strong
Potentially Strong
Potentially Poor
Poor
Overall Sensitivity
CAP
ZSP
LONSNS
TIMDEL
TP15DEG
QD0AVG
QD.25SEC
QDMAX
TQDMAX
QMAX
TQMAX
Q1SEC
AOADMX
TADMAX
AD1SEC
AOAMAX
TAOAMX
AOA1SEC
DELAOA
TCAPTR
TSETTL
PS
ENERGY
VDOTMX
DELV
LONRMS
ELEVRMS
CHR
Time to Pitch Through 15 deg
Avg Initial Pitch Accel Over 0.25 sec
Pitch Acceleration at 0.25 sec
Max Pitch Acceleration
Time of Max Pitch Acceleration
Max Pitch Rate
Time of Max Pitch Rate
Pitch Rate at 1.0 sec
Max Angle of Attack Rate
Time of Max AOA Rate
Angle of Attack Rate at 1.0 sec
Maximum Angle of Attack
Time of Max Angle of Attack
Angle of Attack at 1.0 sec
Change in AOA
Time to Capture
Time to Settle
Final Time Specific Excess Power
Change in Specific Energy
Max Acceleration/Deceleration
Change in Equivalent Airspeed
RMS of Longitudinal Stick Position
RMS of Elevation Tracking Error
Cooper-Harper Rating

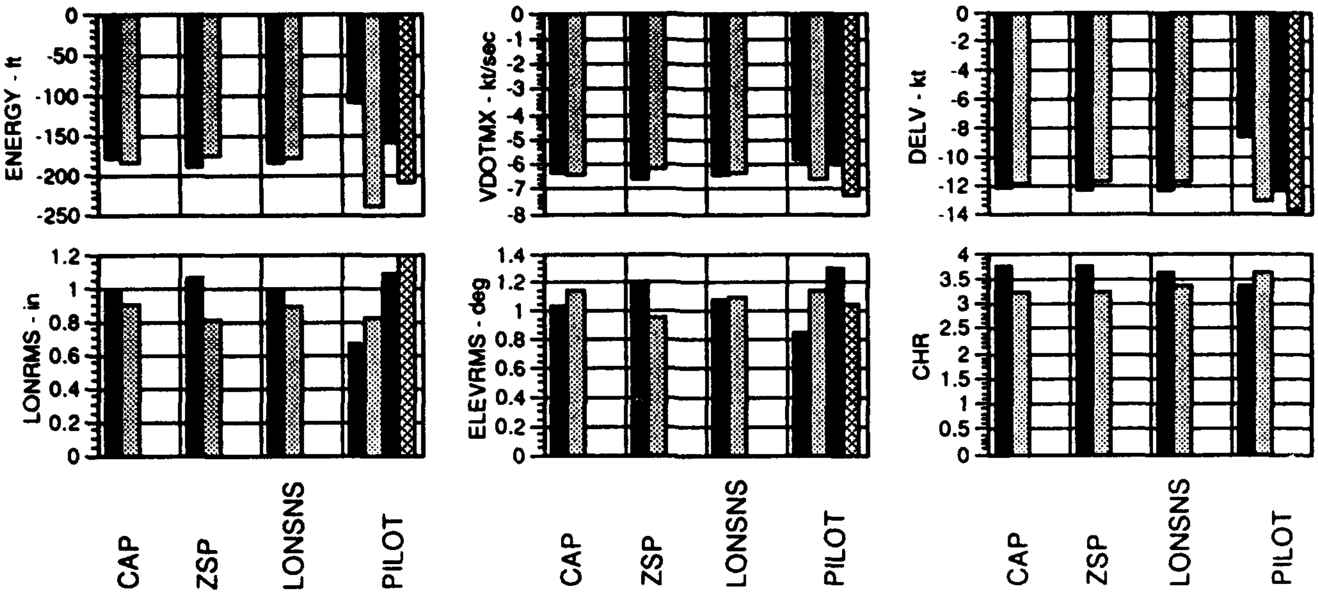
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | TPXDEG | 0.9999 | CAP | 1.000 | 1.5535 | 1.235 | 0 | 0 | -0.231 | 2.69 | 2 | 1 | 2 |
| | (15 deg) | | ZSP | 1.000 | 1.3203 | 1.4744 | 0 | 0 | 0.111 | 1.29 | 3 | 2 | 4 |
| | | | LONSNS | 1.000 | 1.4239 | 1.3697 | 0 | 0 | -0.039 | 0.45 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 1.344 | 1.4646 | 1.3833 | 1.3888 | 0.086 | | | | |
| 4 | QD0AVG | 0.9999 | CAP | 1.000 | 11.529 | 20.927 | 0 | 0 | 0.632 | 1.94 | 1 | 2 | 2 |
| | (0.25 sec) | | ZSP | 0.719 | 15.412 | 16.861 | 0 | 0 | 0.090 | 0.28 | 4 | 3 | 4 |
| | | | LONSNS | 0.240 | 16.079 | 16.196 | 0 | 0 | 0.007 | 0.02 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 20.97 | 15.218 | 14.664 | 13.744 | -0.326 | | | | |
| 5 | QDXSEC | 0.9999 | CAP | 1.000 | 21.861 | 41.19 | 0 | 0 | 0.677 | 1.68 | 1 | 2 | 2 |
| | (0.25 sec) | | ZSP | 0.216 | 30.802 | 31.869 | 0 | 0 | 0.034 | 0.08 | 4 | 3 | 4 |
| | | | LONSNS | 0.722 | 30.924 | 31.764 | 0 | 0 | 0.027 | 0.07 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 36.669 | 24.761 | 32.164 | 32.572 | -0.403 | | | | |
| 6 | QDMAX | 0.9999 | CAP | 1.000 | 25.598 | 46.639 | 0 | 0 | 0.637 | 2.56 | 1 | 1 | 1 |
| | | | ZSP | 0.517 | 35.721 | 36.103 | 0 | 0 | 0.011 | 0.04 | 4 | 3 | 4 |
| | | | LONSNS | 1.000 | 34.325 | 37.563 | 0 | 0 | 0.090 | 0.36 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 39.267 | 30.703 | 36.026 | 38.282 | -0.249 | | | | |
| 7 | TQDMAX | 0.9999 | CAP | 0.566 | 0.3005 | 0.2889 | 0 | 0 | -0.039 | 0.20 | 4 | 3 | 4 |
| | | | ZSP | 0.840 | 0.3056 | 0.2841 | 0 | 0 | -0.073 | 0.37 | 4 | 3 | 4 |
| | | | LONSNS | 0.960 | 0.2796 | 0.3107 | 0 | 0 | 0.106 | 0.53 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 0.232 | 0.2824 | 0.3562 | 0.3128 | 0.198 | | | | |
| 8 | QMAX | 0.9999 | CAP | 1.000 | 15.471 | 19.572 | 0 | 0 | 0.237 | 1.93 | 2 | 2 | 3 |
| | | | ZSP | 1.000 | 19.527 | 15.435 | 0 | 0 | -0.237 | 1.93 | 2 | 2 | 3 |
| | | | LONSNS | 1.000 | 16.838 | 18.15 | 0 | 0 | 0.075 | 0.61 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 17.818 | 15.757 | 18.491 | 18.106 | -0.123 | | | | |
| 9 | TQMAX | 0.9999 | CAP | 1.000 | 1.2438 | 0.8939 | 0 | 0 | -0.336 | 4.14 | 2 | 1 | 2 |
| | | | ZSP | 0.382 | 1.084 | 1.0606 | 0 | 0 | -0.022 | 0.27 | 4 | 3 | 4 |
| | | | LONSNS | 0.944 | 1.0873 | 1.0567 | 0 | 0 | -0.029 | 0.35 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 0.998 | 1.0824 | 1.0937 | 1.1148 | 0.081 | | | | |
| 10 | QXSEC | 0.9999 | CAP | 1.000 | 14.686 | 18.327 | 0 | 0 | 0.223 | 2.27 | 2 | 1 | 2 |
| | (1.0 sec) | | ZSP | 1.000 | 18.225 | 14.716 | 0 | 0 | -0.215 | 2.19 | 2 | 1 | 2 |
| | | | LONSNS | 0.998 | 16.082 | 16.875 | 0 | 0 | 0.048 | 0.49 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 16.488 | 14.948 | 17.079 | 17.575 | -0.098 | | | | |
| 11 | AOADMX | 0.9999 | CAP | 1.000 | 13.739 | 17.86 | 0 | 0 | 0.265 | 2.52 | 2 | 1 | 2 |
| | | | ZSP | 1.000 | 17.763 | 13.756 | 0 | 0 | -0.258 | 2.46 | 2 | 1 | 2 |
| | | | LONSNS | 1.000 | 15.107 | 16.439 | 0 | 0 | 0.085 | 0.80 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 15.551 | 14 | 16.881 | 16.863 | -0.105 | | | | |
| 12 | TADMAX | 0.9999 | CAP | 1.000 | 1.214 | 0.8759 | 0 | 0 | -0.332 | 3.14 | 2 | 1 | 2 |
| | | | ZSP | 0.962 | 1.0752 | 1.0214 | 0 | 0 | -0.051 | 0.49 | 4 | 3 | 4 |
| | | | LONSNS | 0.871 | 1.0594 | 1.0367 | 0 | 0 | -0.022 | 0.20 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 0.966 | 1.0735 | 1.0646 | 1.0868 | 0.106 | | | | |
| 13 | ADXSEC | 0.9999 | CAP | 1.000 | 13.161 | 16.55 | 0 | 0 | 0.231 | 3.59 | 2 | 1 | 2 |
| | (1.0 sec) | | ZSP | 1.000 | 16.589 | 13.055 | 0 | 0 | -0.242 | 3.75 | 2 | 1 | 2 |
| | | | LONSNS | 0.998 | 14.43 | 15.229 | 0 | 0 | 0.054 | 0.84 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 14.213 | 13.327 | 15.568 | 16.39 | -0.064 | | | | |
| 20 | AOAMX | 0.9999 | CAP | 0.951 | 46.208 | 46.736 | 0 | 0 | 0.011 | 0.13 | 4 | 3 | 4 |
| | | | ZSP | 1.000 | 47.131 | 45.801 | 0 | 0 | -0.029 | 0.32 | 4 | 3 | 4 |
| | | | LONSNS | 0.318 | 46.525 | 46.405 | 0 | 0 | -0.003 | 0.03 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 44.679 | 48.905 | 45.574 | 46.378 | 0.090 | | | | |
| 21 | TAOAMX | 0.9999 | CAP | 1.000 | 2.3727 | 1.929 | 0 | 0 | -0.209 | 0.74 | 2 | 3 | 4 |
| | | | ZSP | 1.000 | 1.9615 | 2.3489 | 0 | 0 | 0.181 | 0.64 | 3 | 3 | 4 |
| | | | LONSNS | 0.832 | 2.2085 | 2.0998 | 0 | 0 | -0.050 | 0.18 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 1.866 | 2.4629 | 2.0687 | 2.1828 | 0.281 | | | | |
| 22 | AOAXSEC | 0.9999 | CAP | 1.000 | 35.225 | 39.981 | 0 | 0 | 0.127 | 5.43 | 3 | 1 | 3 |
| | (1.0 sec) | | ZSP | 1.000 | 38.083 | 37.03 | 0 | 0 | -0.028 | 1.20 | 4 | 2 | 4 |
| | | | LONSNS | 0.999 | 37.136 | 37.994 | 0 | 0 | 0.023 | 0.98 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 37.96 | 38.857 | 36.777 | 36.444 | 0.023 | | | | |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23 | DELAOA | 0.9999 | CAP | 0.703 | 16.39 | 16.122 | 0 | 0 | -0.016 | 0.07 | 4 | 3 | 4 |
| | | | ZSP | 0.505 | 16.177 | 16.341 | 0 | 0 | 0.010 | 0.04 | 4 | 3 | 4 |
| | | | LONSNS | 0.262 | 16.298 | 16.218 | 0 | 0 | -0.005 | 0.02 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 13.823 | 17.306 | 15.772 | 17.99 | 0.227 | | | | |
| 25 | TCAPTR | 0.9998 | CAP | 0.986 | 1.9852 | 1.699 | 0 | 0 | -0.156 | 0.63 | 3 | 3 | 4 |
| | | | ZSP | 0.783 | 1.9213 | 1.7685 | 0 | 0 | -0.083 | 0.34 | 4 | 3 | 4 |
| | | | LONSNS | 0.788 | 1.9123 | 1.7748 | 0 | 0 | -0.075 | 0.30 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 1.506 | 1.9236 | 2.2333 | 1.7228 | 0.247 | | | | |
| 26 | TSETTL | 0.9999 | CAP | 0.456 | 0.2039 | 0.27 | 0 | 0 | 0.285 | #DIV/0! | 4 | | 4 |
| | | | ZSP | 0.995 | 0.3902 | 0.0824 | 0 | 0 | -2.263 | #DIV/0! | 1 | | 1 |
| | | | LONSNS | 0.405 | 0.2654 | 0.206 | 0 | 0 | -0.256 | #DIV/0! | 4 | | 4 |
| | | | PLT | 0.999 | 0 | 0.1786 | 0.65 | 0.14 | 0.000 | | | | |
| 36 | PS | 0.9999 | CAP | 0.983 | -35.727 | -40.152 | 0 | 0 | -0.117 | 0.09 | 3 | 3 | 4 |
| | | | ZSP | 0.961 | -35.898 | -39.895 | 0 | 0 | -0.106 | 0.08 | 3 | 3 | 4 |
| | | | LONSNS | 0.147 | -37.773 | -38.025 | 0 | 0 | -0.007 | 0.01 | 4 | 3 | 4 |
| | | | PLT | 1.000 | -19.03 | -56.007 | -10.847 | -62.447 | -1.302 | | | | |
| 37 | ENERGY | 0.9999 | CAP | 0.608 | -178.52 | -185.62 | 0 | 0 | -0.039 | 0.05 | 4 | 3 | 4 |
| | | | ZSP | 0.916 | -189.07 | -174.93 | 0 | 0 | 0.078 | 0.09 | 4 | 3 | 4 |
| | | | LONSNS | 0.589 | -185.41 | -178.45 | 0 | 0 | 0.038 | 0.04 | 4 | 3 | 4 |
| | | | PLT | 1.000 | -110.55 | -240.99 | -160.49 | -208.04 | -0.861 | | | | |
| 38 | VDOTMX | 0.9999 | CAP | 0.497 | -6.3674 | -6.4366 | 0 | 0 | -0.011 | 0.08 | 4 | 3 | 4 |
| | | | ZSP | 1.000 | -6.6476 | -6.155 | 0 | 0 | 0.077 | 0.55 | 4 | 3 | 4 |
| | | | LONSNS | 0.466 | -6.4337 | -6.3676 | 0 | 0 | 0.010 | 0.07 | 4 | 3 | 4 |
| | | | PLT | 1.000 | -5.7781 | -6.6413 | -5.898 | -7.2389 | -0.140 | | | | |
| 39 | DELV | 0.9999 | CAP | 0.530 | -12.175 | -11.855 | 0 | 0 | 0.027 | 0.06 | 4 | 3 | 4 |
| | | | ZSP | 0.870 | -12.361 | -11.676 | 0 | 0 | 0.057 | 0.13 | 4 | 3 | 4 |
| | | | LONSNS | 0.851 | -12.33 | -11.694 | 0 | 0 | 0.053 | 0.12 | 4 | 3 | 4 |
| | | | PLT | 1.000 | -8.6713 | -13.125 | -12.369 | -13.789 | -0.426 | | | | |
| 42 | LONRMS | 0.9999 | CAP | 0.814 | 0.9749 | 0.898 | 0 | 0 | -0.082 | 0.38 | 4 | 3 | 4 |
| | | | ZSP | 1.000 | 1.0671 | 0.8073 | 0 | 0 | -0.283 | 1.29 | 2 | 2 | 3 |
| | | | LONSNS | 0.920 | 0.9867 | 0.8857 | 0 | 0 | -0.108 | 0.49 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 0.6639 | 0.825 | 1.0841 | 1.1951 | 0.219 | | | | |
| 44 | ELEVRMS | 0.9998 | CAP | 0.875 | 1.0329 | 1.1436 | 0 | 0 | 0.102 | 0.35 | 4 | 3 | 4 |
| | | | ZSP | 0.999 | 1.2093 | 0.965 | 0 | 0 | -0.228 | 0.78 | 2 | 3 | 4 |
| | | | LONSNS | 0.226 | 1.0783 | 1.0964 | 0 | 0 | 0.017 | 0.06 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 0.8529 | 1.1385 | 1.3033 | 1.0565 | 0.293 | | | | |
| 49 | CHR | 0 | CAP | -999.000 | 3.75 | 3.25 | 0 | 0 | -0.144 | 2.01 | 4 | 1 | 4 |
| | | | ZSP | -999.000 | 3.75 | 3.25 | 0 | 0 | -0.144 | 2.01 | 4 | 1 | 4 |
| | | | LONSNS | -999.000 | 3.625 | 3.375 | 0 | 0 | -0.072 | 1.00 | 4 | 2 | 4 |
| | | | PLT | -999.000 | 3.375 | 3.625 | -999 | -999 | 0.072 | | | | |

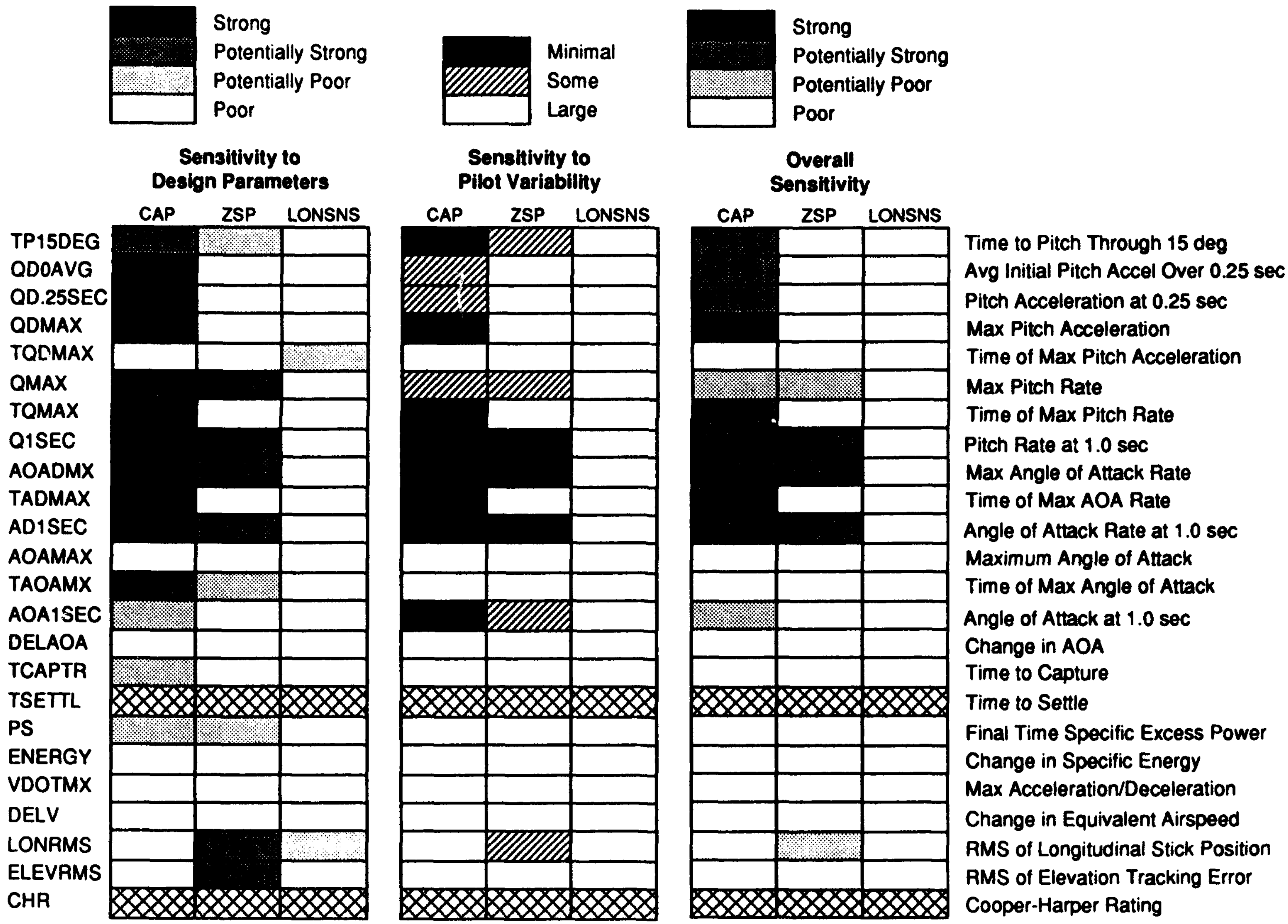
STEM 7 TEST 7 ANALYSIS B



STEM 7 TEST 7 ANALYSIS B

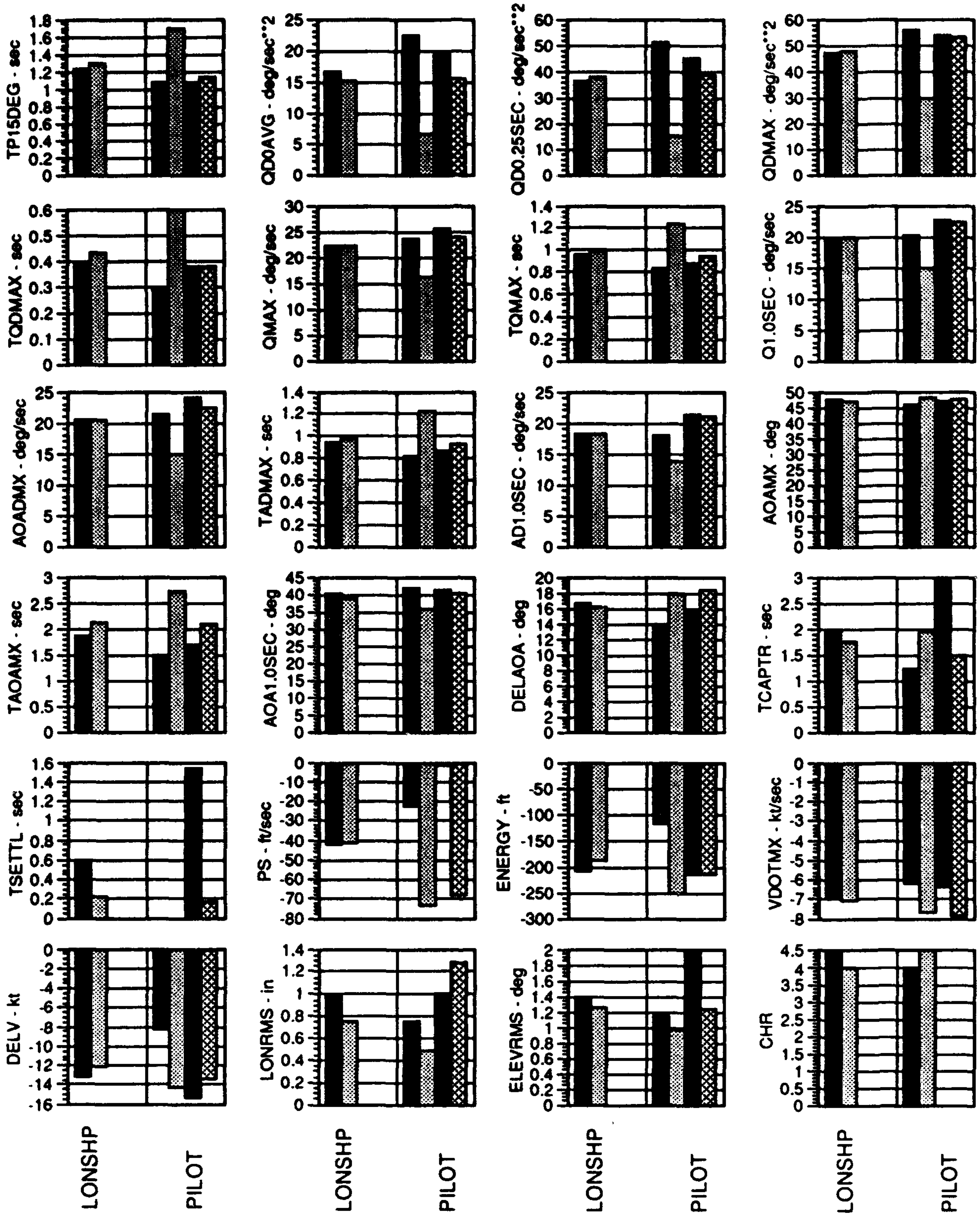


STEM 7 TEST 7 ANALYSIS B

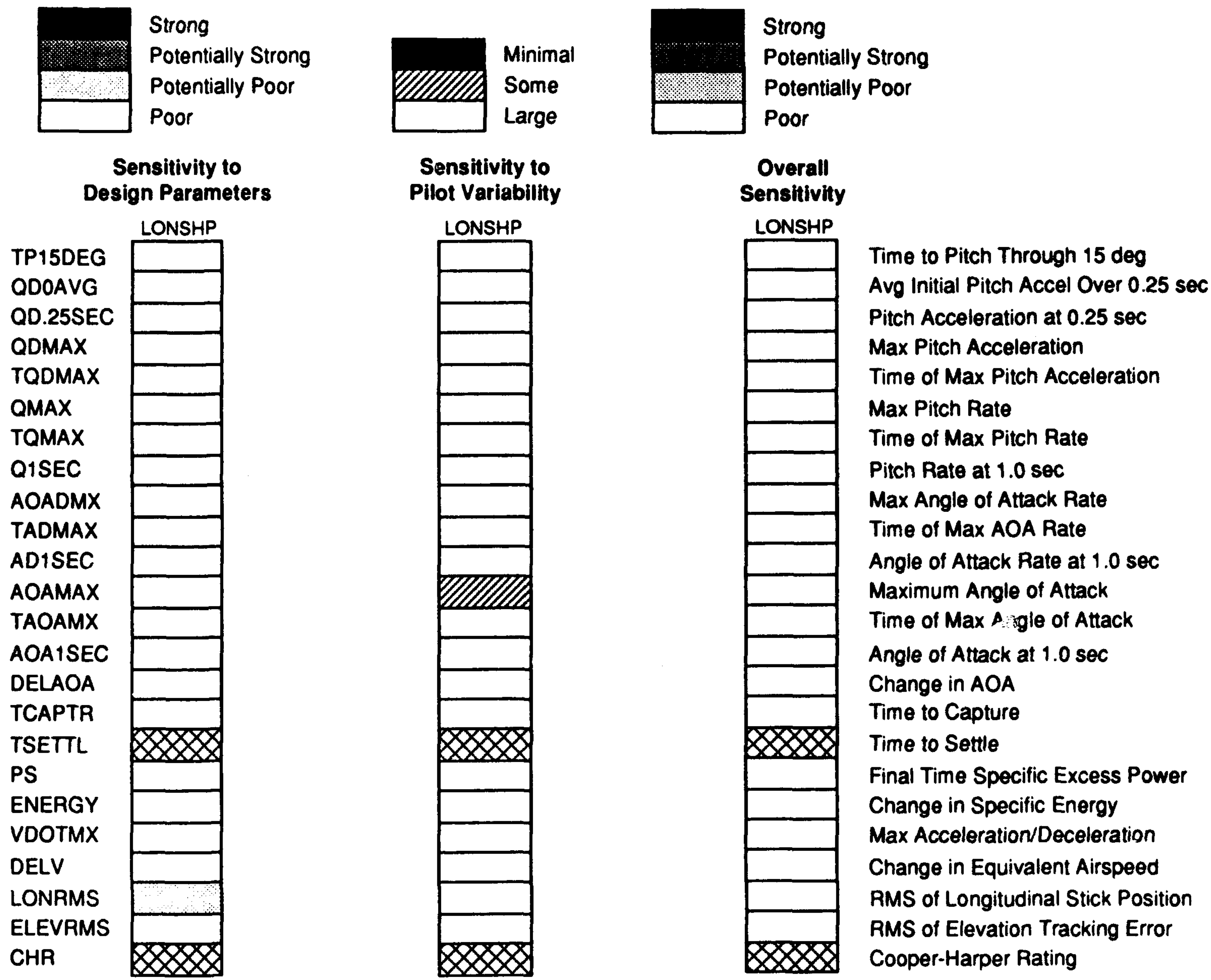


| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | TPXDEG | 0.9991 | LONSHP | 0.519 | 1.2253 | 1.2854 | 0 | 0 | 0.048 | 0.10 | 4 | 3 | 4 |
| | (15 deg) | | PLT | 1.000 | 1.0766 | 1.6978 | 1.0715 | 1.1416 | 0.471 | | | | |
| 4 | QD0AVG | 0.8758 | LONSHP | 0.302 | 16.602 | 15.159 | 0 | 0 | -0.091 | 0.06 | 4 | 3 | 4 |
| | (0.25 sec) | | PLT | 0.969 | 22.274 | 6.5775 | 19.41 | 15.504 | -1.546 | | | | |
| 5 | QDXSEC | 0.9926 | LONSHP | 0.122 | 36.692 | 37.56 | 0 | 0 | 0.023 | 0.01 | 4 | 3 | 4 |
| | (0.25 sec) | | PLT | 0.999 | 51.413 | 14.8 | 45.142 | 38.632 | -1.593 | | | | |
| 6 | QDMAX | 0.9981 | LONSHP | 0.186 | 47.125 | 48.046 | 0 | 0 | 0.019 | 0.03 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 55.904 | 29.472 | 53.953 | 52.798 | -0.685 | | | | |
| 7 | TQDMAX | 0.9765 | LONSHP | 0.546 | 0.3919 | 0.4318 | 0 | 0 | 0.097 | 0.12 | 4 | 3 | 4 |
| | | | PLT | 0.997 | 0.2909 | 0.5975 | 0.3799 | 0.375 | 0.784 | | | | |
| 8 | QMAX | 0.9993 | LONSHP | 0.045 | 22.108 | 22.173 | 0 | 0 | 0.003 | 0.01 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 23.628 | 16.265 | 25.531 | 23.881 | -0.382 | | | | |
| 9 | TQMAX | 0.9996 | LONSHP | 0.551 | 0.9586 | 0.9961 | 0 | 0 | 0.038 | 0.09 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 0.8337 | 1.2405 | 0.8799 | 0.9416 | 0.408 | | | | |
| 10 | QXSEC | 0.9629 | LONSHP | 0.032 | 19.887 | 19.828 | 0 | 0 | -0.003 | 0.01 | 4 | 3 | 4 |
| | (1.0 sec) | | PLT | 0.996 | 20.199 | 14.881 | 22.806 | 22.307 | -0.310 | | | | |
| 11 | AOADMX | 0.9989 | LONSHP | 0.041 | 20.479 | 20.538 | 0 | 0 | 0.003 | 0.01 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 21.308 | 15.019 | 23.977 | 22.524 | -0.357 | | | | |
| 12 | TADMAX | 0.9999 | LONSHP | 0.414 | 0.9502 | 0.9747 | 0 | 0 | 0.025 | 0.06 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 0.8123 | 1.2262 | 0.8632 | 0.9333 | 0.424 | | | | |
| 13 | ADXSEC | 0.952 | LONSHP | 0.068 | 18.297 | 18.174 | 0 | 0 | -0.007 | 0.03 | 4 | 3 | 4 |
| | (1.0 sec) | | PLT | 0.994 | 17.817 | 13.832 | 21.165 | 20.911 | -0.256 | | | | |
| 20 | AOAMX | 0.847 | LONSHP | 0.676 | 47.422 | 46.786 | 0 | 0 | -0.013 | 0.29 | 4 | 3 | 4 |
| | | | PLT | 0.895 | 45.861 | 48.051 | 46.95 | 47.499 | 0.047 | | | | |
| 21 | TAOAMX | 0.9843 | LONSHP | 0.806 | 1.8503 | 2.1248 | 0 | 0 | 0.139 | 0.22 | 4 | 3 | 4 |
| | | | PLT | 0.998 | 1.4766 | 2.7051 | 1.6965 | 2.0833 | 0.643 | | | | |
| 22 | AOAXSEC | 0.9738 | LONSHP | 0.731 | 40.367 | 39.061 | 0 | 0 | -0.033 | 0.21 | 4 | 3 | 4 |
| | (1.0 sec) | | PLT | 0.996 | 41.579 | 35.645 | 41.354 | 40.427 | -0.155 | | | | |
| 23 | DELAOA | 0.9999 | LONSHP | 0.694 | 16.661 | 16.131 | 0 | 0 | -0.032 | 0.13 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 14.002 | 17.837 | 15.53 | 18.286 | 0.244 | | | | |
| 25 | TCAPTR | 0.9995 | LONSHP | 0.692 | 1.9836 | 1.7676 | 0 | 0 | -0.116 | 0.24 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 1.2266 | 1.955 | 2.9049 | 1.475 | 0.483 | | | | |
| 26 | TSETTL | 0.9999 | LONSHP | 0.925 | 0.5917 | 0.2286 | 0 | 0 | -1.101 | #DIV/0! | 1 | | 1 |
| | | | PLT | 1.000 | 0 | 0 | 1.5417 | 0.175 | 0.000 | | | | |
| 36 | PS | 0.9999 | LONSHP | 0.406 | -42.33 | -40.88 | 0 | 0 | 0.035 | 0.02 | 4 | 3 | 4 |
| | | | PLT | 1.000 | -22.22 | -73.04 | -1.03 | -67.88 | -1.491 | | | | |
| 37 | ENERGY | 0.9982 | LONSHP | 0.733 | -209.3 | -188 | 0 | 0 | 0.107 | 0.13 | 4 | 3 | 4 |
| | | | PLT | 1.000 | -117.2 | -250.3 | -213.9 | -214.8 | -0.834 | | | | |
| 38 | VDOTMX | 0.9924 | LONSHP | 0.353 | -6.921 | -7.059 | 0 | 0 | -0.020 | 0.09 | 4 | 3 | 4 |
| | | | PLT | 0.999 | -6.134 | -7.635 | -6.353 | -7.896 | -0.221 | | | | |
| 39 | DELV | 0.9998 | LONSHP | 0.759 | -13.23 | -12.2 | 0 | 0 | 0.081 | 0.14 | 4 | 3 | 4 |
| | | | PLT | 1.000 | -8.192 | -14.29 | -15.31 | -13.38 | -0.586 | | | | |
| 42 | LONRMS | 0.9018 | LONSHP | 0.826 | 0.9889 | 0.7546 | 0 | 0 | -0.274 | 0.62 | 3 | 3 | 4 |
| | | | PLT | 0.976 | 0.7536 | 0.49 | 1.0086 | 1.2791 | -0.444 | | | | |
| 44 | ELEVRMS | 0.9946 | LONSHP | 0.625 | 1.3815 | 1.2515 | 0 | 0 | -0.099 | 0.55 | 4 | 3 | 4 |
| | | | PLT | 0.999 | 1.1515 | 0.9636 | 1.9705 | 1.2451 | -0.179 | | | | |
| 49 | CHR | 0 | LONSHP | -999.000 | 4.5 | 4 | 0 | 0 | -0.118 | 1.00 | 4 | 2 | 4 |
| | | | PLT | -999.000 | 4 | 4.5 | -999 | -999 | 0.118 | | | | |

## STEM 7 TEST 7 ANALYSIS C



STEM 7 TEST 7 ANALYSIS C



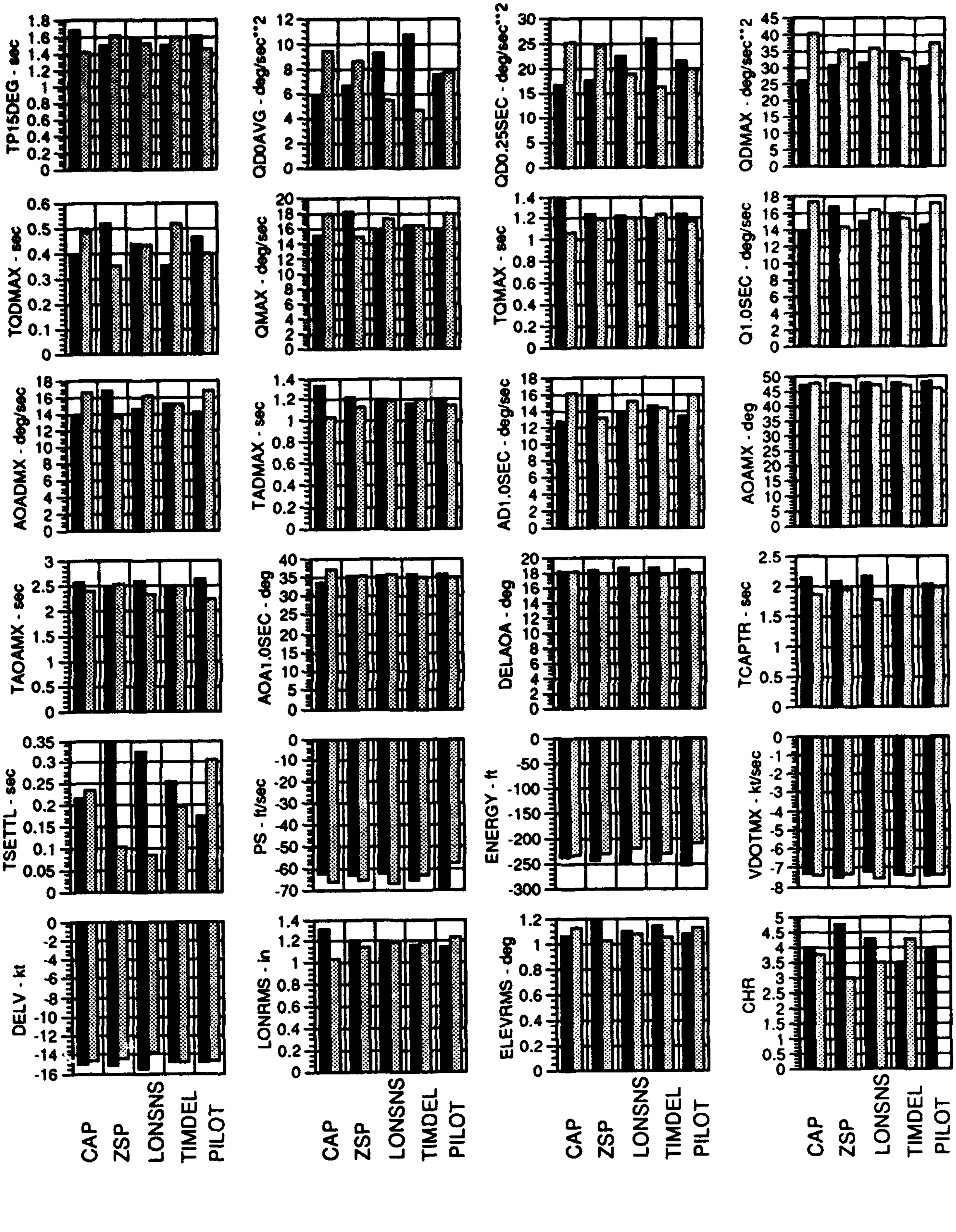
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | TPXDEG | 0.9999 | CAP | 1.000 | 1.6793 | 1.4153 | 0 | 0 | -0.172 | 1.85 | 3 | 2 | 4 |
| | (15 deg) | | ZSP | 1.000 | 1.4841 | 1.6105 | 0 | 0 | 0.082 | 0.88 | 4 | 3 | 4 |
| | | | LONSNS | 0.987 | 1.5726 | 1.5118 | 0 | 0 | -0.039 | 0.42 | 4 | 3 | 4 |
| | | | TIMDEL | 1.000 | 1.4972 | 1.5941 | 0 | 0 | 0.063 | 0.68 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 1.6042 | 1.4619 | 0 | 0 | -0.093 | | | | |
| 4 | QD0AVG | 0.9999 | CAP | 1.000 | 5.8406 | 9.3865 | 0 | 0 | 0.492 | 38.07 | 1 | 1 | 1 |
| | (0.25 sec) | | ZSP | 0.977 | 6.6663 | 8.5607 | 0 | 0 | 0.253 | 19.54 | 2 | 1 | 2 |
| | | | LONSNS | 1.000 | 9.2235 | 5.3596 | 0 | 0 | -0.570 | 44.06 | 1 | 1 | 1 |
| | | | TIMDEL | 1.000 | 10.816 | 4.6173 | 0 | 0 | -0.958 | 74.05 | 1 | 1 | 1 |
| | | | PLT | 0.206 | 7.5741 | 7.6727 | 0 | 0 | 0.013 | | | | |
| 5 | QDXSEC | 0.9999 | CAP | 1.000 | 16.591 | 25.347 | 0 | 0 | 0.437 | 5.20 | 1 | 1 | 1 |
| | (0.25 sec) | | ZSP | 1.000 | 17.379 | 24.559 | 0 | 0 | 0.353 | 4.20 | 2 | 1 | 2 |
| | | | LONSNS | 0.909 | 22.485 | 18.846 | 0 | 0 | -0.177 | 2.11 | 3 | 1 | 3 |
| | | | TIMDEL | 1.000 | [illegible] | 16.264 | 0 | 0 | -0.486 | 5.79 | 1 | 1 | 1 |
| | | | PLT | 0.752 | 21.656 | 19.922 | 0 | 0 | -0.084 | | | | |
| 6 | QDMAX | 0.9999 | CAP | 1.000 | 25.883 | [illegible] | 0 | 0 | 0.462 | 2.13 | 1 | 1 | 1 |
| | | | ZSP | 1.000 | 30.892 | 35.455 | 0 | 0 | 0.138 | 0.64 | 3 | 3 | 4 |
| | | | LONSNS | 1.000 | 31.147 | 36.01 | 0 | 0 | 0.146 | 0.67 | 3 | 3 | 4 |
| | | | TIMDEL | 0.768 | 33.616 | 32.76 | 0 | 0 | -0.026 | 0.12 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 30.272 | 37.526 | 0 | 0 | 0.216 | | | | |
| 7 | TQDMAX | 0.5987 | CAP | 0.729 | 0.3892 | 0.4819 | 0 | 0 | 0.215 | 1.44 | 4 | 2 | 4 |
| | | | ZSP | 0.946 | 0.5207 | 0.3504 | 0 | 0 | -0.406 | 2.72 | 1 | 1 | 1 |
| | | | LONSNS | 0.049 | 0.4369 | 0.4336 | 0 | 0 | -0.007 | 0.05 | 4 | 3 | 4 |
| | | | TIMDEL | 0.934 | 0.3506 | 0.515 | 0 | 0 | 0.394 | 2.64 | 2 | 1 | 2 |
| | | | PLT | 0.439 | 0.461 | 0.3973 | 0 | 0 | -0.149 | | | | |
| 8 | QMAX | 0.9999 | CAP | 1.000 | 15.016 | 17.829 | 0 | 0 | 0.173 | 1.11 | 3 | 2 | 4 |
| | | | ZSP | 1.000 | 18.128 | 14.717 | 0 | 0 | -0.210 | 1.35 | 2 | 2 | 3 |
| | | | LONSNS | 1.000 | 15.776 | 17.327 | 0 | 0 | 0.094 | 0.61 | 4 | 3 | 4 |
| | | | TIMDEL | 0.405 | 16.45 | 16.397 | 0 | 0 | -0.003 | 0.02 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 15.394 | 17.965 | 0 | 0 | 0.155 | | | | |
| 9 | TQMAX | 0.9999 | CAP | 1.000 | 1.3659 | 1.0619 | 0 | 0 | -0.254 | 5.54 | 2 | 1 | 2 |
| | | | ZSP | 0.997 | 1.2407 | 1.1871 | 0 | 0 | -0.044 | 0.96 | 4 | 3 | 4 |
| | | | LONSNS | 0.379 | 1.2155 | 1.2118 | 0 | 0 | -0.003 | 0.07 | 4 | 3 | 4 |
| | | | TIMDEL | 0.986 | 1.1868 | 1.2393 | 0 | 0 | 0.043 | 0.94 | 4 | 3 | 4 |
| | | | PLT | 0.956 | 1.2361 | 1.1806 | 0 | 0 | -0.046 | | | | |
| 10 | QXSEC | 0.9999 | CAP | 1.000 | 13.676 | 17.329 | 0 | 0 | 0.239 | 1.40 | 2 | 2 | 3 |
| | (1.0 sec) | | ZSP | 1.000 | 16.749 | 14.256 | 0 | 0 | -0.162 | 0.95 | 3 | 3 | 4 |
| | | | LONSNS | 1.000 | 14.894 | 16.355 | 0 | 0 | 0.094 | 0.55 | 4 | 3 | 4 |
| | | | TIMDEL | 0.726 | 15.635 | 15.378 | 0 | 0 | -0.017 | 0.10 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 14.433 | 17.106 | 0 | 0 | 0.171 | | | | |
| 11 | AOADMX | 0.9999 | CAP | 1.000 | 13.776 | 16.577 | 0 | 0 | 0.186 | 1.07 | 3 | 2 | 4 |
| | | | ZSP | 1.000 | 16.821 | 13.532 | 0 | 0 | -0.219 | 1.27 | 2 | 2 | 3 |
| | | | LONSNS | 1.000 | 14.549 | 16.055 | 0 | 0 | 0.099 | 0.57 | 4 | 3 | 4 |
| | | | TIMDEL | 0.261 | 15.176 | 15.177 | 0 | 0 | 0.000 | 0.00 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 14.114 | 16.77 | 0 | 0 | 0.173 | | | | |
| 12 | TADMAX | 0.9999 | CAP | 1.000 | 1.3309 | 1.0369 | 0 | 0 | -0.252 | 4.37 | 2 | 1 | 2 |
| | | | ZSP | 1.000 | 1.2307 | 1.1371 | 0 | 0 | -0.079 | 1.37 | 4 | 2 | 4 |
| | | | LONSNS | 0.235 | 1.1783 | 1.1918 | 0 | 0 | 0.011 | 0.20 | 4 | 3 | 4 |
| | | | TIMDEL | 0.985 | 1.1575 | 1.2086 | 0 | 0 | 0.043 | 0.75 | 4 | 3 | 4 |
| | | | PLT | 0.991 | 1.2111 | 1.1431 | 0 | 0 | -0.058 | | | | |
| 13 | ADXSEC | 0.9999 | CAP | 1.000 | 12.674 | 16.102 | 0 | 0 | 0.242 | 1.29 | 2 | 2 | 3 |
| | (1.0 sec) | | ZSP | 1.000 | 15.614 | 13.162 | 0 | 0 | -0.172 | 0.91 | 3 | 3 | 4 |
| | | | LONSNS | 1.000 | 13.805 | 15.204 | 0 | 0 | 0.097 | 0.52 | 4 | 3 | 4 |
| | | | TIMDEL | 0.642 | 14.489 | 14.293 | 0 | 0 | -0.014 | 0.07 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 13.297 | 16.024 | 0 | 0 | 0.188 | | | | |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | AOAMX | 0.9986 | CAP | 0.180 | 47.236 | 47.323 | 0 | 0 | 0.002 | 0.04 | 4 | 3 | 4 |
| | | | ZSP | 0.856 | 47.563 | 46.996 | 0 | 0 | -0.012 | 0.27 | 4 | 3 | 4 |
| | | | LONSNS | 0.884 | 47.545 | 46.909 | 0 | 0 | -0.013 | 0.31 | 4 | 3 | 4 |
| | | | TIMDEL | 0.935 | 47.62 | 46.962 | 0 | 0 | -0.014 | 0.32 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 48.11 | 46.035 | 0 | 0 | -0.044 | | | | |
| 21 | TAOAMX | 0.9046 | CAP | 0.676 | 2.5443 | 2.392 | 0 | 0 | -0.062 | 0.39 | 4 | 3 | 4 |
| | | | ZSP | 0.544 | 2.4058 | 2.5305 | 0 | 0 | 0.051 | 0.32 | 4 | 3 | 4 |
| | | | LONSNS | 0.912 | 2.5769 | 2.3159 | 0 | 0 | -0.107 | 0.67 | 3 | 3 | 4 |
| | | | TIMDEL | 0.068 | 2.4576 | 2.478 | 0 | 0 | 0.008 | 0.05 | 4 | 3 | 4 |
| | | | PLT | 0.977 | 2.6223 | 2.2369 | 0 | 0 | -0.160 | | | | |
| 22 | AOAXSEC | 0.9999 | CAP | 1.000 | 33.687 | 37.179 | 0 | 0 | 0.099 | 5.28 | 4 | 1 | 4 |
| | (1.0 sec) | | ZSP | 0.696 | 35.344 | 35.522 | 0 | 0 | 0.005 | 0.27 | 4 | 3 | 4 |
| | | | LONSNS | 0.894 | 35.201 | 35.757 | 0 | 0 | 0.016 | 0.84 | 4 | 3 | 4 |
| | | | TIMDEL | 0.997 | 36.036 | 34.869 | 0 | 0 | -0.033 | 1.76 | 4 | 2 | 4 |
| | | | PLT | 0.954 | 35.697 | 35.036 | 0 | 0 | -0.019 | | | | |
| 23 | DELAOA | 0.9989 | CAP | 0.261 | 18.222 | 18.092 | 0 | 0 | -0.007 | 0.31 | 4 | 3 | 4 |
| | | | ZSP | 0.729 | 18.369 | 17.946 | 0 | 0 | -0.023 | 1.01 | 4 | 2 | 4 |
| | | | LONSNS | 0.940 | 18.478 | 17.708 | 0 | 0 | -0.043 | 1.84 | 4 | 2 | 4 |
| | | | TIMDEL | 0.968 | 18.573 | 17.769 | 0 | 0 | -0.044 | 1.91 | 4 | 2 | 4 |
| | | | PLT | 0.738 | 18.325 | 17.905 | 0 | 0 | -0.023 | | | | |
| 25 | TCAPTR | 0.9399 | CAP | 0.943 | 2.1393 | 1.8436 | 0 | 0 | -0.149 | 4.45 | 3 | 1 | 3 |
| | | | ZSP | 0.699 | 2.0607 | 1.9222 | 0 | 0 | -0.070 | 2.08 | 4 | 1 | 4 |
| | | | LONSNS | 0.982 | 2.1469 | 1.7738 | 0 | 0 | -0.192 | 5.72 | 3 | 1 | 3 |
| | | | TIMDEL | 0.010 | 1.9834 | 1.999 | 0 | 0 | 0.008 | 0.23 | 4 | 3 | 4 |
| | | | PLT | 0.207 | 2.0181 | 1.9515 | 0 | 0 | -0.034 | | | | |
| 26 | TSETTL | 0.8265 | CAP | 0.116 | 0.215 | 0.2367 | 0 | 0 | 0.096 | 0.16 | 4 | 3 | 4 |
| | | | ZSP | 0.889 | 0.3467 | 0.105 | 0 | 0 | -1.499 | 2.54 | 2 | 1 | 2 |
| | | | LONSNS | 0.870 | 0.3257 | 0.086 | 0 | 0 | -1.761 | 2.98 | 2 | 1 | 2 |
| | | | TIMDEL | 0.419 | 0.2569 | 0.1968 | 0 | 0 | -0.270 | 0.46 | 4 | 3 | 4 |
| | | | PLT | 0.640 | 0.1736 | 0.3042 | 0 | 0 | 0.591 | | | | |
| 36 | PS | 0.9997 | CAP | 0.942 | -62.334 | -66.286 | 0 | 0 | -0.062 | 0.37 | 4 | 3 | 4 |
| | | | ZSP | 0.784 | -63.168 | -65.452 | 0 | 0 | -0.036 | 0.21 | 4 | 3 | 4 |
| | | | LONSNS | 0.976 | -62.323 | -67.092 | 0 | 0 | -0.074 | 0.45 | 4 | 3 | 4 |
| | | | TIMDEL | 0.748 | -65.647 | -63.059 | 0 | 0 | 0.040 | 0.24 | 4 | 3 | 4 |
| | | | PLT | 1.000 | -68.466 | -58.076 | 0 | 0 | 0.165 | | | | |
| 37 | ENERGY | 0.9857 | CAP | 0.213 | -239.41 | -235.97 | 0 | 0 | 0.014 | 0.08 | 4 | 3 | 4 |
| | | | ZSP | 0.729 | -244.61 | -230.77 | 0 | 0 | 0.058 | 0.32 | 4 | 3 | 4 |
| | | | LONSNS | 0.967 | -249.56 | -221.07 | 0 | 0 | 0.122 | 0.68 | 3 | 3 | 4 |
| | | | TIMDEL | 0.790 | -244.95 | -230.89 | 0 | 0 | 0.059 | 0.33 | 4 | 3 | 4 |
| | | | PLT | 0.998 | -254.33 | -212.73 | 0 | 0 | 0.180 | | | | |
| 38 | VDOTMX | 0.2038 | CAP | 0.137 | -7.3663 | -7.3994 | 0 | 0 | -0.004 | 1.65 | 4 | 2 | 4 |
| | | | ZSP | 0.680 | -7.4799 | -7.2858 | 0 | 0 | 0.026 | 9.68 | 4 | 1 | 4 |
| | | | LONSNS | 0.877 | -7.2587 | -7.5567 | 0 | 0 | -0.040 | 14.81 | 4 | 1 | 4 |
| | | | TIMDEL | 0.011 | -7.3899 | -7.3762 | 0 | 0 | 0.002 | 0.68 | 4 | 3 | 4 |
| | | | PLT | 0.169 | -7.3909 | -7.3708 | 0 | 0 | 0.003 | | | | |
| 39 | DELV | 0.8938 | CAP | 0.465 | -15.04 | -14.587 | 0 | 0 | 0.031 | 1.96 | 4 | 2 | 4 |
| | | | ZSP | 0.647 | -15.137 | -14.49 | 0 | 0 | 0.044 | 2.80 | 4 | 1 | 4 |
| | | | LONSNS | 0.978 | -15.542 | -13.793 | 0 | 0 | 0.120 | 7.66 | 3 | 1 | 3 |
| | | | TIMDEL | 0.284 | -14.893 | -14.739 | 0 | 0 | 0.010 | 0.67 | 4 | 3 | 4 |
| | | | PLT | 0.145 | -14.906 | -14.675 | 0 | 0 | 0.016 | | | | |
| 42 | LONRMS | 0.9987 | CAP | 0.995 | 1.3223 | 1.0378 | 0 | 0 | -0.245 | 2.93 | 2 | 1 | 2 |
| | | | ZSP | 0.611 | 1.2121 | 1.148 | 0 | 0 | -0.054 | 0.65 | 4 | 3 | 4 |
| | | | LONSNS | 0.093 | 1.1724 | 1.1908 | 0 | 0 | 0.016 | 0.19 | 4 | 3 | 4 |
| | | | TIMDEL | 0.358 | 1.1009 | 1.198 | 0 | 0 | 0.031 | 0.38 | 4 | 3 | 4 |
| | | | PLT | 0.704 | 1.1404 | 1.2396 | 0 | 0 | 0.083 | | | | |

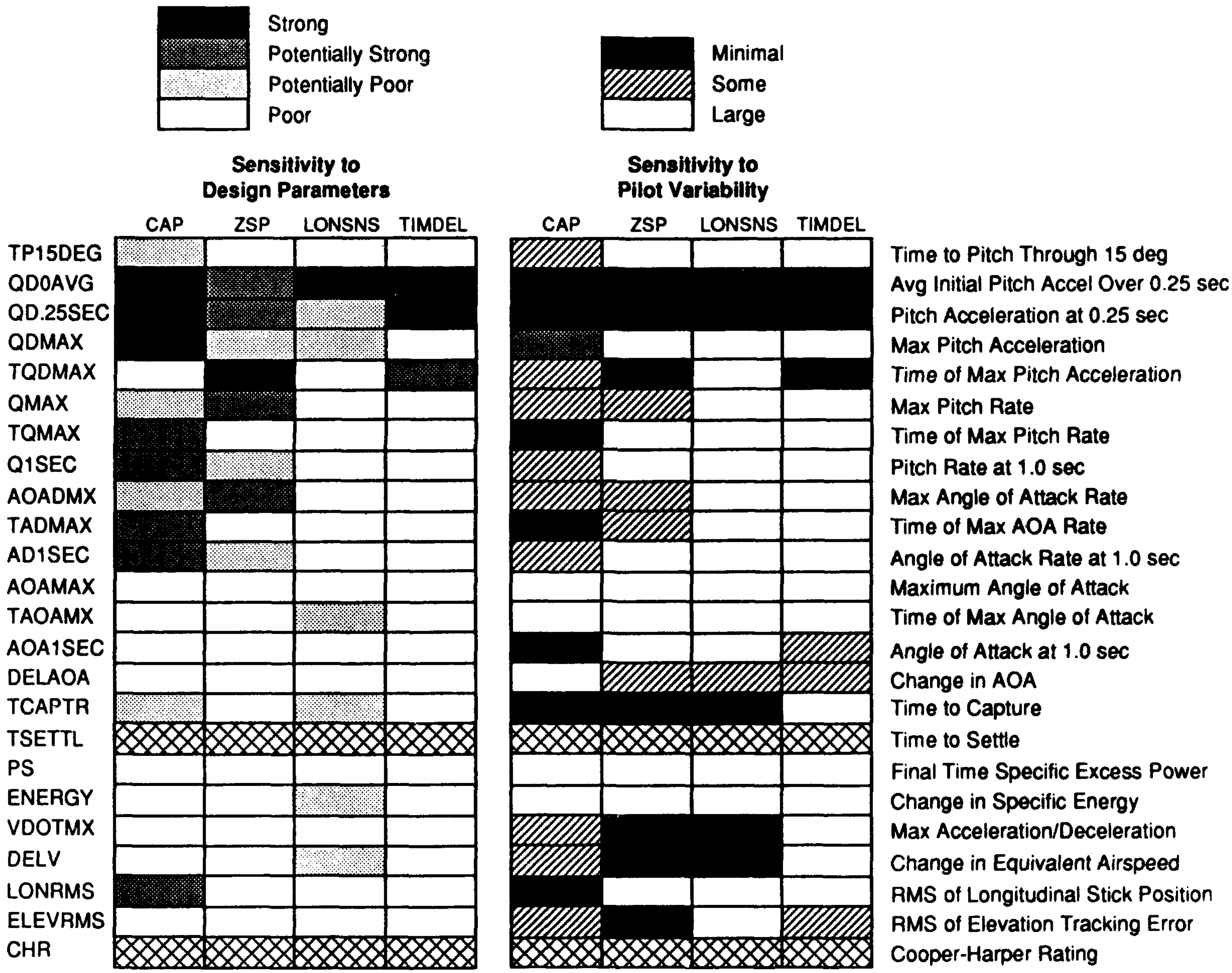
STEM 7 TEST 7 ANALYSIS D

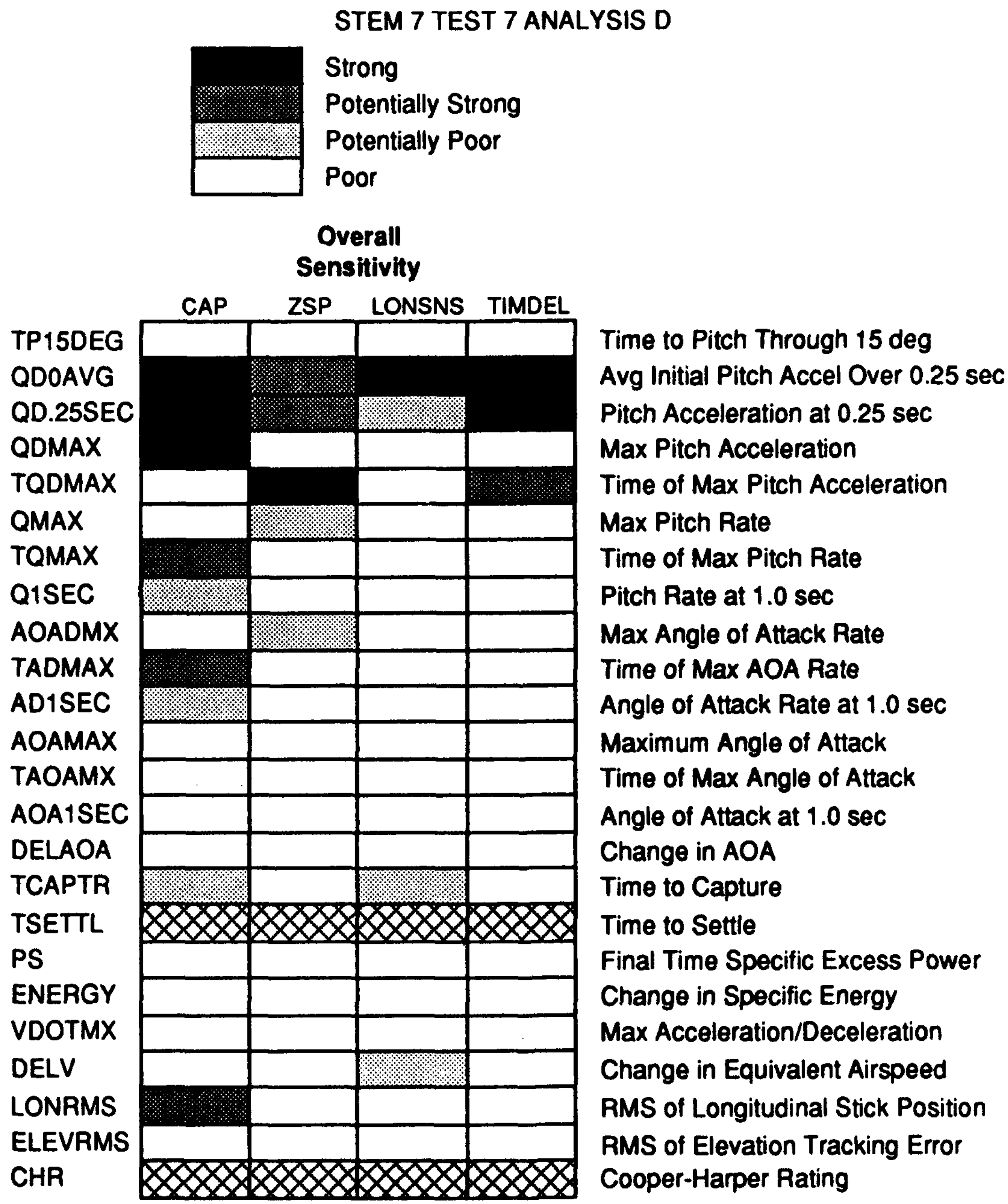
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 44 | ELEVRMS | 0.5435 | CAP | 0.411 | 1.064 | 1.1219 | 0 | 0 | 0.053 | 1.13 | 4 | 2 | 4 |
| | | | ZSP | 0.812 | 1.1658 | 1.02 | 0 | 0 | -0.134 | 2.84 | 4 | 1 | 4 |
| | | | LONSNS | 0.207 | 1.1075 | 1.0725 | 0 | 0 | -0.032 | 0.68 | 4 | 3 | 4 |
| | | | TIMDEL | 0.645 | 1.14 | 1.0489 | 0 | 0 | -0.083 | 1.77 | 4 | 2 | 4 |
| | | | PLT | 0.318 | 1.0723 | 1.1239 | 0 | 0 | 0.047 | | | | |
| 49 | CHR | 0 | CAP | -999.000 | 4 | 3.75 | 0 | 0 | -0.065 | 0.00 | 4 | 3 | 4 |
| | | | ZSP | -999.000 | 4.75 | 3 | 0 | 0 | -0.476 | 0.00 | 4 | 3 | 4 |
| | | | LONSNS | -999.000 | 4.25 | 3.5 | 0 | 0 | -0.195 | 0.00 | 4 | 3 | 4 |
| | | | TIMDEL | -999.000 | 3.5 | 4.25 | 0 | 0 | 0.195 | 0.00 | 4 | 3 | 4 |
| | | | PLT | -999.000 | 3.875 | -999 | 0 | 0 | -129.905 | | | | |

STEM 7 TEST 7 ANALYSIS D



STEM 7 TEST 7 ANALYSIS D

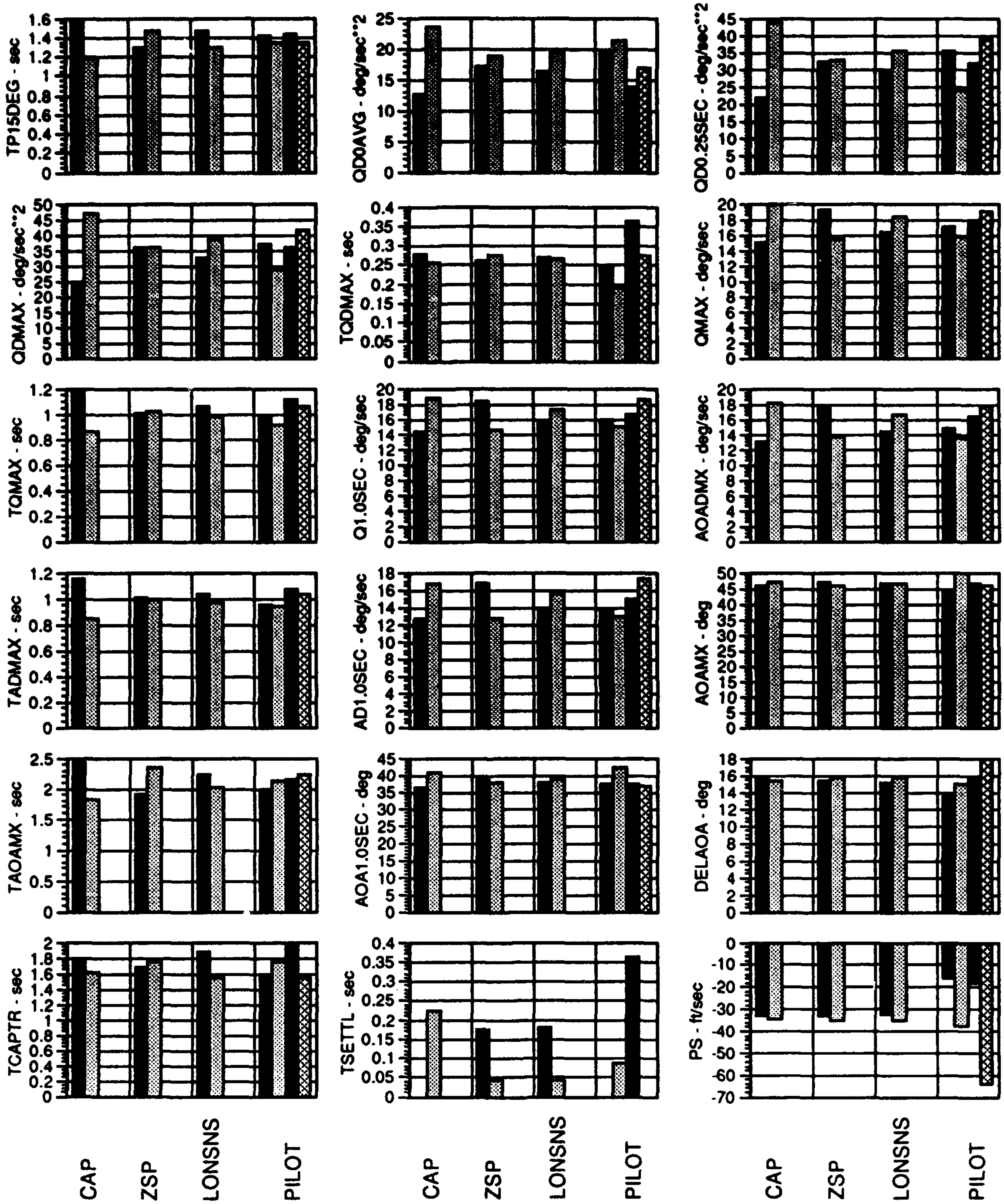



STEM 7 TEST 7 ANALYSIS D
Strong
Potentially Strong
Potentially Poor
Poor
Overall Sensitivity
CAP
ZSP
LONSNS
TIMDEL
TP15DEG
QD0AVG
QD.25SEC
QDMAX
TQDMAX
QMAX
TQMAX
Q1SEC
AOADMX
TADMAX
AD1SEC
AOAMAX
TAOAMX
AOA1SEC
DELAOA
TCAPTR
TSETTL
PS
ENERGY
VDOTMX
DELV
LONRMS
ELEVRMS
CHR
Time to Pitch Through 15 deg
Avg Initial Pitch Accel Over 0.25 sec
Pitch Acceleration at 0.25 sec
Max Pitch Acceleration
Time of Max Pitch Acceleration
Max Pitch Rate
Time of Max Pitch Rate
Pitch Rate at 1.0 sec
Max Angle of Attack Rate
Time of Max AOA Rate
Angle of Attack Rate at 1.0 sec
Maximum Angle of Attack
Time of Max Angle of Attack
Angle of Attack at 1.0 sec
Change in AOA
Time to Capture
Time to Settle
Final Time Specific Excess Power
Change in Specific Energy
Max Acceleration/Deceleration
Change in Equivalent Airspeed
RMS of Longitudinal Stick Position
RMS of Elevation Tracking Error
Cooper-Harper Rating

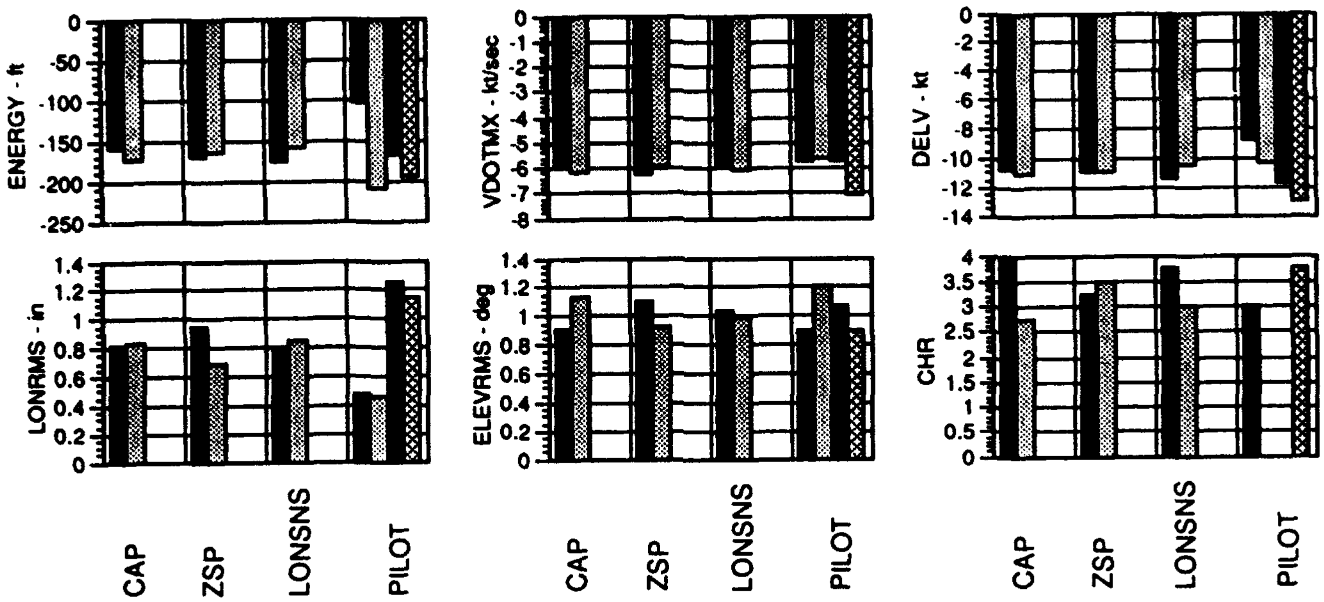
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | TPXDEG | 0.9999 | CAP | 1.000 | 1.5701 | 1.1866 | 0 | 0 | -0.284 | 6.82 | 2 | 1 | 2 |
| | (15 deg) | | ZSP | 1.000 | 1.2985 | 1.4695 | 0 | 0 | 0.124 | 2.98 | 3 | 1 | 3 |
| | | | LONSNS | 1.000 | 1.4711 | 1.297 | 0 | 0 | -0.126 | 3.04 | 3 | 1 | 3 |
| | | | PLT | 0.963 | 1.4073 | 1.35 | 1.4272 | 1.3425 | -0.042 | | | | |
| 4 | QD0AVG | 0.9999 | CAP | 1.000 | 12.662 | 23.387 | 0 | 0 | 0.653 | 9.32 | 1 | 1 | 1 |
| | (0.25 sec) | | ZSP | 0.624 | 17.18 | 18.681 | 0 | 0 | 0.084 | 1.20 | 4 | 2 | 4 |
| | | | LONSNS | 0.971 | 16.374 | 19.395 | 0 | 0 | 0.170 | 2.43 | 3 | 1 | 3 |
| | | | PLT | 0.996 | 19.74 | 21.172 | 13.765 | 16.831 | 0.070 | | | | |
| 5 | QDXSEC | 0.9999 | CAP | 1.000 | 21.875 | 43.651 | 0 | 0 | 0.747 | 1.86 | 1 | 2 | 2 |
| | (0.25 sec) | | ZSP | 0.022 | 32.305 | 32.786 | 0 | 0 | 0.015 | 0.04 | 4 | 3 | 4 |
| | | | LONSNS | 0.999 | 29.729 | 35.24 | 0 | 0 | 0.171 | 0.43 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 35.39 | 23.931 | 31.73 | 38.875 | -0.401 | | | | |
| 6 | QDMAX | 0.9999 | CAP | 1.000 | 24.95 | 47.15 | 0 | 0 | 0.680 | 2.58 | 1 | 1 | 1 |
| | | | ZSP | 0.157 | 35.712 | 35.939 | 0 | 0 | 0.006 | 0.02 | 4 | 3 | 4 |
| | | | LONSNS | 1.000 | 32.774 | 38.751 | 0 | 0 | 0.168 | 0.64 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 37.226 | 28.681 | 35.794 | 41.475 | -0.264 | | | | |
| 7 | TQDMAX | 0.9998 | CAP | 0.670 | 0.2781 | 0.2554 | 0 | 0 | -0.085 | 0.31 | 4 | 3 | 4 |
| | | | ZSP | 0.552 | 0.2585 | 0.2758 | 0 | 0 | 0.065 | 0.24 | 4 | 3 | 4 |
| | | | LONSNS | 0.277 | 0.2711 | 0.263 | 0 | 0 | -0.030 | 0.11 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 0.2458 | 0.1875 | 0.3606 | 0.2758 | -0.274 | | | | |
| 8 | QMAX | 0.9999 | CAP | 1.000 | 14.955 | 19.986 | 0 | 0 | 0.294 | 4.17 | 2 | 1 | 2 |
| | | | ZSP | 1.000 | 19.23 | 15.533 | 0 | 0 | -0.215 | 3.05 | 2 | 1 | 2 |
| | | | LONSNS | 1.000 | 16.339 | 18.457 | 0 | 0 | 0.122 | 1.73 | 3 | 2 | 4 |
| | | | PLT | 1.000 | 16.958 | 15.804 | 18.026 | 18.928 | -0.071 | | | | |
| 9 | TQMAX | 0.9999 | CAP | 1.000 | 1.1761 | 0.8554 | 0 | 0 | -0.324 | 4.59 | 2 | 1 | 2 |
| | | | ZSP | 0.561 | 1.0105 | 1.0279 | 0 | 0 | 0.017 | 0.24 | 4 | 3 | 4 |
| | | | LONSNS | 0.987 | 1.0565 | 0.983 | 0 | 0 | -0.072 | 1.02 | 4 | 2 | 4 |
| | | | PLT | 1.000 | 0.9881 | 0.9208 | 1.1106 | 1.0592 | -0.071 | | | | |
| 10 | QXSEC | 0.9999 | CAP | 1.000 | 14.437 | 18.719 | 0 | 0 | 0.263 | 4.72 | 2 | 1 | 2 |
| | (1.0 sec) | | ZSP | 1.000 | 18.448 | 14.541 | 0 | 0 | -0.240 | 4.31 | 2 | 1 | 2 |
| | | | LONSNS | 0.999 | 15.757 | 17.28 | 0 | 0 | 0.092 | 1.66 | 4 | 2 | 4 |
| | | | PLT | 1.000 | 15.985 | 15.119 | 16.492 | 18.587 | -0.056 | | | | |
| 11 | AOADMX | 0.9999 | CAP | 1.000 | 13.126 | 18.105 | 0 | 0 | 0.3[illegible] | 3.45 | 2 | 1 | 2 |
| | | | ZSP | 1.000 | 17.371 | 13.684 | 0 | 0 | -0.241 | 2.54 | 2 | 1 | 2 |
| | | | LONSNS | 1.000 | 14.454 | 16.631 | 0 | 0 | 0.141 | 1.48 | 3 | 2 | 4 |
| | | | PLT | 1.000 | 14.763 | 13.428 | 16.442 | 17.693 | -0.095 | | | | |
| 12 | TADMAX | 0.9999 | CAP | 1.000 | 1.1521 | 0.8429 | 0 | 0 | -0.318 | 15.18 | 2 | 1 | 2 |
| | | | ZSP | 0.243 | 1.0085 | 0.9924 | 0 | 0 | -0.016 | 0.77 | 4 | 3 | 4 |
| | | | LONSNS | 0.944 | 1.0295 | 0.973 | 0 | 0 | -0.056 | 2.70 | 4 | 1 | 4 |
| | | | PLT | 0.991 | 0.9573 | 0.9375 | 1.0772 | 1.0342 | -0.021 | | | | |
| 13 | ADXSEC | 0.9999 | CAP | 1.000 | 12.76 | 16.763 | 0 | 0 | 0.276 | 4.19 | 2 | 1 | 2 |
| | (1.0 sec) | | ZSP | 1.000 | 16.654 | 12.707 | 0 | 0 | -0.274 | 4.15 | 2 | 1 | 2 |
| | | | LONSNS | 0.999 | 13.945 | 15.465 | 0 | 0 | 0.104 | 1.57 | 3 | 2 | 4 |
| | | | PLT | 1.000 | 13.735 | 12.859 | 15.005 | 17.366 | -0.066 | | | | |
| 20 | AOAMX | 0.9999 | CAP | 0.970 | 46.089 | 46.78 | 0 | 0 | 0.015 | 0.13 | 4 | 3 | 4 |
| | | | ZSP | 1.000 | 47.001 | 45.83 | 0 | 0 | -0.025 | 0.21 | 4 | 3 | 4 |
| | | | LONSNS | 0.117 | 46.446 | 46.41 | 0 | 0 | -0.001 | 0.01 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 44.034 | 49.557 | 46.223 | 46.095 | 0.118 | | | | |
| 21 | TAOAMX | 0.9999 | CAP | 1.000 | 2.4241 | 1.8095 | 0 | 0 | -0.297 | 4.33 | 2 | 1 | 2 |
| | | | ZSP | 1.000 | 1.8965 | 2.3591 | 0 | 0 | 0.220 | 3.21 | 2 | 1 | 2 |
| | | | LONSNS | 0.994 | 2.2336 | 2.017 | 0 | 0 | -0.102 | 1.49 | 3 | 2 | 4 |
| | | | PLT | 0.877 | 1.9804 | 2.1208 | 2.1689 | 2.2342 | 0.069 | | | | |
| 22 | AOAXSEC | 0.9999 | CAP | 1.000 | 36.128 | 40.79 | 0 | 0 | 0.122 | 0.90 | 3 | 3 | 4 |
| | (1.0 sec) | | ZSP | 0.999 | 39.032 | 37.765 | 0 | 0 | -0.033 | 0.24 | 4 | 3 | 4 |
| | | | LONSNS | 0.959 | 38.055 | 38.754 | 0 | 0 | 0.018 | 0.13 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 37.143 | 42.518 | 37.102 | 36.987 | 0.136 | | | | |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23 | DELAOA | 0.9999 | CAP | 0.804 | 15.701 | 15.325 | 0 | 0 | -0.024 | 0.23 | 4 | 3 | 4 |
| | | | ZSP | 0.950 | 15.237 | 15.808 | 0 | 0 | 0.037 | 0.35 | 4 | 3 | 4 |
| | | | LONSNS | 0.961 | 15.207 | 15.815 | 0 | 0 | 0.039 | 0.37 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 13.513 | 15.014 | 15.747 | 17.96 | 0.106 | | | | |
| 25 | TCAPTR | 0.995 | CAP | 0.882 | 1.8001 | 1.6241 | 0 | 0 | -0.103 | 1.12 | 4 | 2 | 4 |
| | | | ZSP | 0.357 | 1.6905 | 1.7383 | 0 | 0 | 0.028 | 0.30 | 4 | 3 | 4 |
| | | | LONSNS | 0.997 | 1.8899 | 1.545 | 0 | 0 | -0.203 | 2.20 | 2 | 1 | 2 |
| | | | PLT | 0.968 | 1.5919 | 1.7458 | 1.9897 | 1.5384 | 0.092 | | | | |
| 26 | TSETTL | 0.9966 | CAP | 0.963 | 0 | 0.225 | 0 | 0 | 0.000 | #NUM! | 4 | | 2 |
| | | | ZSP | 0.798 | 0.174 | 0.0438 | 0 | 0 | -1.863 | #DIV/0! | 4 | | 2 |
| | | | LONSNS | 0.806 | 0.1813 | 0.042 | 0 | 0 | -2.042 | #DIV/0! | 2 | | 2 |
| | | | PLT | 0.936 | 0 | 0.0875 | 0.3625 | 0 | 0.000 | | | | |
| 36 | PS | 0.9999 | CAP | 0.400 | -33.148 | -34.362 | 0 | 0 | -0.036 | 0.04 | 4 | 3 | 4 |
| | | | ZSP | 0.687 | -32.58 | -34.954 | 0 | 0 | -0.070 | 0.07 | 4 | 3 | 4 |
| | | | LONSNS | 0.705 | -32.534 | -34.903 | 0 | 0 | -0.070 | 0.07 | 4 | 3 | 4 |
| | | | PLT | 1.000 | -16.045 | -38.004 | -18.266 | -64.13 | -0.973 | | | | |
| 37 | ENERGY | 0.9999 | CAP | 0.967 | -160.74 | -174.34 | 0 | 0 | -0.081 | 0.11 | 4 | 3 | 4 |
| | | | ZSP | 0.746 | -170.74 | -163.92 | 0 | 0 | 0.041 | 0.05 | 4 | 3 | 4 |
| | | | LONSNS | 0.974 | -174.72 | -160.38 | 0 | 0 | 0.086 | 0.11 | 4 | 3 | 4 |
| | | | PLT | 1.000 | -104.49 | -208.52 | -166.6 | -195.23 | -0.747 | | | | |
| 38 | VDOTMX | 0.9999 | CAP | 0.992 | -5.9177 | -6.1798 | 0 | 0 | -0.043 | 2.21 | 4 | 1 | 4 |
| | | | ZSP | 1.000 | -6.2173 | -5.8676 | 0 | 0 | 0.058 | 2.95 | 4 | 1 | 4 |
| | | | LONSNS | 0.819 | -5.9809 | -6.1086 | 0 | 0 | -0.021 | 1.08 | 4 | 2 | 4 |
| | | | PLT | 1.000 | -5.7363 | -5.6247 | -5.7552 | -7.0938 | 0.020 | | | | |
| 39 | DELV | 0.9999 | CAP | 0.500 | -10.806 | -11.063 | 0 | 0 | -0.024 | 0.14 | 4 | 3 | 4 |
| | | | ZSP | 0.242 | -10.987 | -10.875 | 0 | 0 | 0.010 | 0.06 | 4 | 3 | 4 |
| | | | LONSNS | 0.993 | -11.483 | -10.403 | 0 | 0 | 0.099 | 0.59 | 4 | 3 | 4 |
| | | | PLT | 1.000 | -8.7502 | -10.333 | -11.8 | -13.027 | -0.167 | | | | |
| 42 | LONRMS | 0.9999 | CAP | 0.112 | 0.8199 | 0.8312 | 0 | 0 | 0.014 | 1.16 | 4 | 2 | 4 |
| | | | ZSP | 0.996 | 0.945 | 0.7008 | 0 | 0 | -0.303 | 25.71 | 2 | 1 | 2 |
| | | | LONSNS | 0.359 | 0.804 | 0.846 | 0 | 0 | 0.051 | 4.31 | 4 | 1 | 4 |
| | | | PLT | 1.000 | 0.4714 | 0.4659 | 1.2504 | 1.1435 | -0.012 | | | | |
| 44 | ELEVRMS | 0.9756 | CAP | 0.986 | 0.9044 | 1.1259 | 0 | 0 | 0.221 | 0.72 | 2 | 3 | 4 |
| | | | ZSP | 0.956 | 1.0982 | 0.924 | 0 | 0 | -0.174 | 0.57 | 3 | 3 | 4 |
| | | | LONSNS | 0.385 | 1.0355 | 0.9912 | 0 | 0 | -0.044 | 0.14 | 4 | 3 | 4 |
| | | | PLT | 0.958 | 0.8908 | 1.2043 | 1.0683 | 0.8983 | 0.306 | | | | |
| 49 | CHR | 0.6901 | CAP | 0.868 | 4 | 2.75 | 0 | 0 | -0.384 | #DIV/0! | 3 | | 3 |
| | | | ZSP | 0.275 | 3.25 | 3.5 | 0 | 0 | 0.074 | #DIV/0! | 4 | | 4 |
| | | | LONSNS | 0.680 | 3.75 | 3 | 0 | 0 | -0.225 | #DIV/0! | 4 | | 4 |
| | | | PLT | -999.000 | 3 | 0 | 0 | 3.75 | 0.000 | | | | |

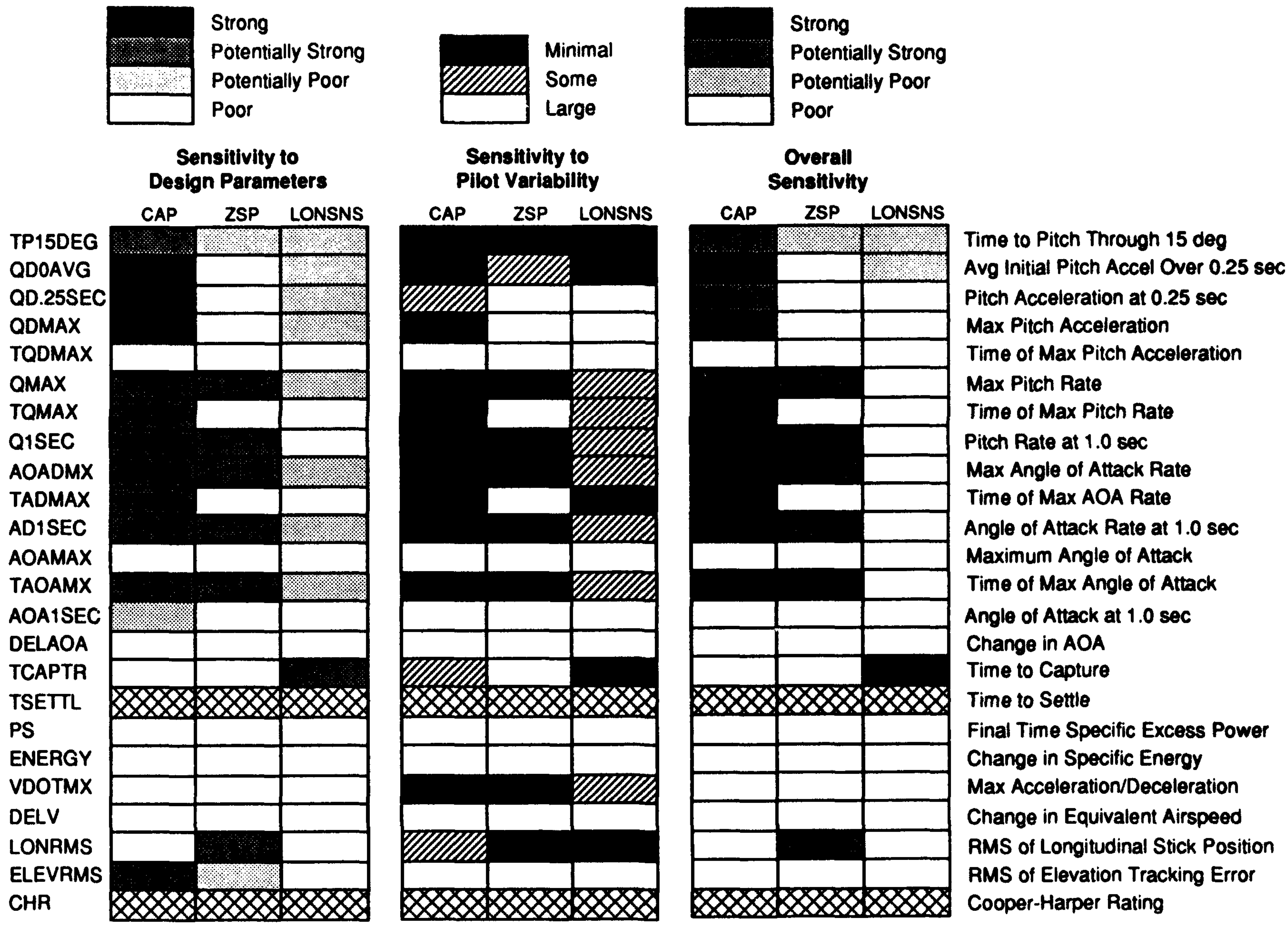
STEM 7 TEST 7 ANALYSIS E



STEM 7 TEST 7 ANALYSIS E



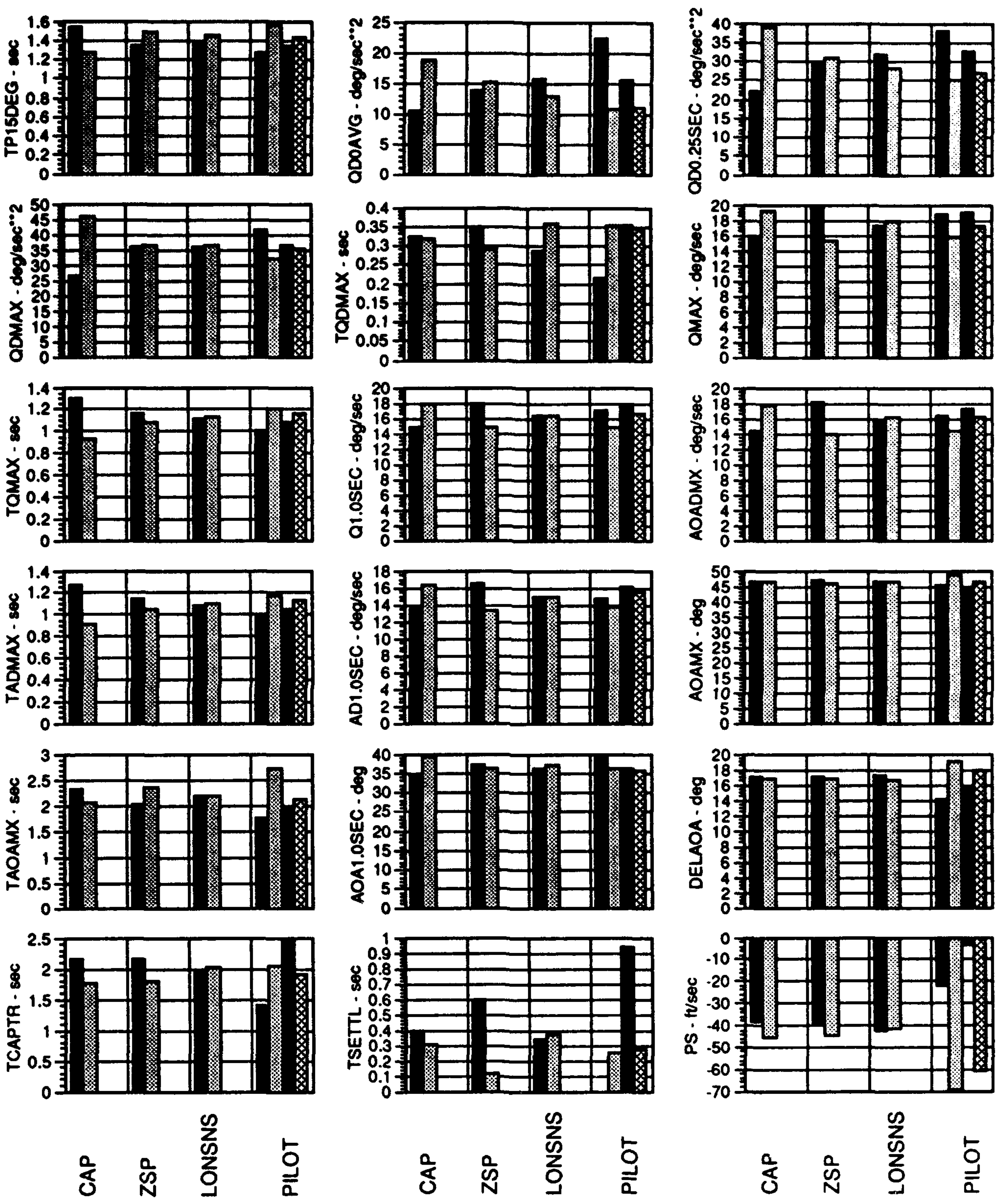
STEM 7 TEST 7 ANALYSIS E



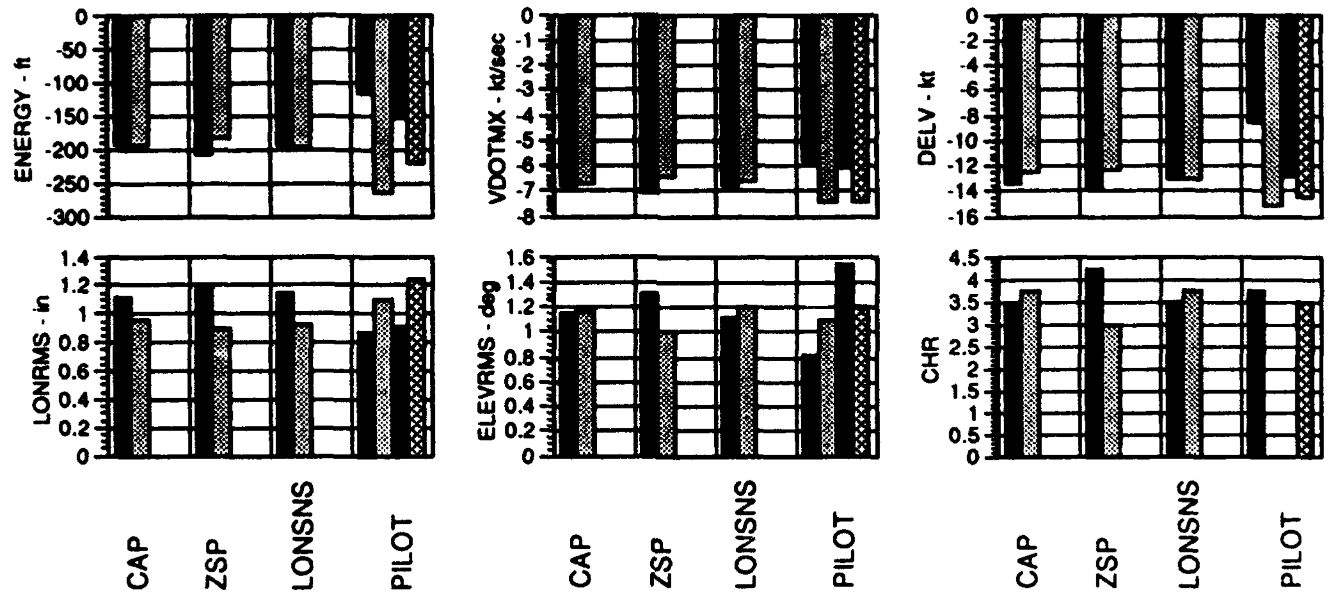
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | TPXDEG | 0.9999 | CAP | 1.000 | 1.538 | 1.2796 | 0 | 0 | -0.185 | 0.94 | 3 | 3 | 4 |
| | (15 deg) | | ZSP | 1.000 | 1.3412 | 1.4787 | 0 | 0 | 0.098 | 0.50 | 4 | 3 | 4 |
| | | | LONSNS | 0.970 | 1.3833 | 1.4425 | 0 | 0 | 0.042 | 0.21 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 1.2754 | 1.5506 | 1.3394 | 1.4315 | 0.197 | | | | |
| 4 | QD0AVG | 0.9999 | CAP | 1.000 | 10.48 | 18.657 | 0 | 0 | 0.609 | 0.77 | 1 | 3 | 3 |
| | (0.25 sec) | | ZSP | 0.555 | 13.711 | 15.243 | 0 | 0 | 0.106 | 0.13 | 4 | 3 | 4 |
| | | | LONSNS | 0.940 | 15.826 | 12.997 | 0 | 0 | -0.198 | 0.25 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 22.302 | 10.754 | 15.563 | 10.894 | -0.796 | | | | |
| 5 | QDXSEC | 0.9999 | CAP | 1.000 | 21.848 | 38.918 | 0 | 0 | 0.610 | 1.47 | 1 | 2 | 2 |
| | (0.25 sec) | | ZSP | 0.356 | 29.357 | 31.054 | 0 | 0 | 0.056 | 0.14 | 4 | 3 | 4 |
| | | | LONSNS | 0.961 | 31.948 | 28.288 | 0 | 0 | -0.122 | 0.29 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 38.054 | 25.384 | 32.598 | 26.753 | -0.416 | | | | |
| 6 | QDMAX | 0.9999 | CAP | 1.000 | 26.197 | 46.167 | 0 | 0 | 0.597 | 2.34 | 1 | 1 | 1 |
| | | | ZSP | 0.626 | 35.729 | 36.249 | 0 | 0 | 0.014 | 0.06 | 4 | 3 | 4 |
| | | | LONSNS | 0.893 | 35.654 | 36.375 | 0 | 0 | 0.020 | 0.08 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 41.479 | 32.219 | 36.257 | 35.335 | -0.255 | | | | |
| 7 | TQDMAX | 0.9999 | CAP | 0.059 | 0.3213 | 0.3199 | 0 | 0 | -0.004 | 0.01 | 4 | 3 | 4 |
| | | | ZSP | 0.997 | 0.3508 | 0.2916 | 0 | 0 | -0.186 | 0.37 | 3 | 3 | 4 |
| | | | LONSNS | 1.000 | 0.2869 | 0.3584 | 0 | 0 | 0.224 | 0.44 | 2 | 3 | 4 |
| | | | PLT | 1.000 | 0.217 | 0.3536 | 0.3519 | 0.3468 | 0.508 | | | | |
| 8 | QMAX | 0.9999 | CAP | 1.000 | 15.948 | 19.189 | 0 | 0 | 0.186 | 1.05 | 3 | 2 | 4 |
| | | | ZSP | 1.000 | 19.813 | 15.348 | 0 | 0 | -0.258 | 1.46 | 2 | 2 | 3 |
| | | | LONSNS | 0.998 | 17.266 | 17.843 | 0 | 0 | 0.033 | 0.19 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 18.75 | 15.721 | 18.955 | 17.347 | -0.177 | | | | |
| 9 | TQMAX | 0.9999 | CAP | 1.000 | 1.3065 | 0.9295 | 0 | 0 | -0.347 | 1.95 | 2 | 2 | 3 |
| | | | ZSP | 0.915 | 1.1547 | 1.0898 | 0 | 0 | -0.058 | 0.33 | 4 | 3 | 4 |
| | | | LONSNS | 0.318 | 1.1137 | 1.1304 | 0 | 0 | 0.015 | 0.08 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 1.0087 | 1.2036 | 1.0769 | 1.1661 | 0.178 | | | | |
| 10 | QXSEC | 0.9999 | CAP | 1.000 | 14.916 | 17.965 | 0 | 0 | 0.187 | 1.34 | 3 | 2 | 4 |
| | (1.0 sec) | | ZSP | 1.000 | 18.011 | 14.872 | 0 | 0 | -0.193 | 1.38 | 3 | 2 | 4 |
| | | | LONSNS | 0.493 | 16.36 | 16.469 | 0 | 0 | 0.007 | 0.05 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 17.034 | 14.819 | 17.666 | 16.64 | -0.140 | | | | |
| 11 | AOADMX | 0.9999 | CAP | 1.000 | 14.307 | 17.635 | 0 | 0 | 0.211 | 1.64 | 2 | 2 | 3 |
| | | | ZSP | 1.000 | 18.14 | 13.82 | 0 | 0 | -0.275 | 2.14 | 2 | 1 | 2 |
| | | | LONSNS | 0.998 | 15.666 | 16.246 | 0 | 0 | 0.036 | 0.28 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 16.404 | 14.428 | 17.319 | 16.097 | -0.129 | | | | |
| 12 | TADMAX | 0.9999 | CAP | 1.000 | 1.2713 | 0.9065 | 0 | 0 | -0.345 | 1.84 | 2 | 2 | 3 |
| | | | ZSP | 0.997 | 1.1393 | 1.0472 | 0 | 0 | -0.084 | 0.45 | 4 | 3 | 4 |
| | | | LONSNS | 0.327 | 1.0851 | 1.1004 | 0 | 0 | 0.014 | 0.07 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 0.9754 | 1.1755 | 1.0519 | 1.1353 | 0.188 | | | | |
| 13 | ADXSEC | 0.9999 | CAP | 1.000 | 13.533 | 16.352 | 0 | 0 | 0.190 | 2.56 | 3 | 1 | 3 |
| | (1.0 sec) | | ZSP | 1.000 | 16.526 | 13.365 | 0 | 0 | -0.214 | 2.88 | 2 | 1 | 2 |
| | | | LONSNS | 0.568 | 14.847 | 14.994 | 0 | 0 | 0.010 | 0.13 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 14.731 | 13.677 | 16.132 | 15.489 | -0.074 | | | | |
| 20 | AOAMX | 0.9999 | CAP | 0.627 | 46.317 | 46.695 | 0 | 0 | 0.008 | 0.13 | 4 | 3 | 4 |
| | | | ZSP | 0.999 | 47.257 | 45.776 | 0 | 0 | -0.032 | 0.49 | 4 | 3 | 4 |
| | | | LONSNS | 0.283 | 46.593 | 46.401 | 0 | 0 | -0.004 | 0.06 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 45.378 | 48.416 | 44.926 | 46.64 | 0.065 | | | | |
| 21 | TAOAMX | 0.992 | CAP | 0.942 | 2.3251 | 2.0392 | 0 | 0 | -0.132 | 0.29 | 3 | 3 | 4 |
| | | | ZSP | 0.971 | 2.0239 | 2.3398 | 0 | 0 | 0.146 | 0.32 | 3 | 3 | 4 |
| | | | LONSNS | 0.092 | 2.1869 | 2.1825 | 0 | 0 | -0.002 | 0.00 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 1.742 | 2.7194 | 1.9686 | 2.1353 | 0.460 | | | | |
| 22 | AOAXSEC | 0.9999 | CAP | 1.000 | 34.388 | 39.235 | 0 | 0 | 0.132 | 1.81 | 3 | 2 | 4 |
| | (1.0 sec) | | ZSP | 0.986 | 37.171 | 36.376 | 0 | 0 | -0.022 | 0.30 | 4 | 3 | 4 |
| | | | LONSNS | 0.980 | 36.348 | 37.234 | 0 | 0 | 0.024 | 0.33 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 38.845 | 36.112 | 36.452 | 35.942 | -0.073 | | | | |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23 | DELAOA | 0.9999 | CAP | 0.317 | 17.028 | 16.859 | 0 | 0 | -0.010 | 0.03 | 4 | 3 | 4 |
| | | | ZSP | 0.464 | 17.081 | 16.814 | 0 | 0 | -0.016 | 0.05 | 4 | 3 | 4 |
| | | | LONSNS | 0.853 | 17.234 | 16.621 | 0 | 0 | -0.036 | 0.12 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 14.16 | 19.024 | 15.796 | 18.017 | 0.300 | | | | |
| 25 | TCAPTR | 0.9944 | CAP | 0.949 | 2.1566 | 1.768 | 0 | 0 | -0.200 | 0.52 | 3 | 3 | 4 |
| | | | ZSP | 0.901 | 2.1431 | 1.7954 | 0 | 0 | -0.178 | 0.46 | 3 | 3 | 4 |
| | | | LONSNS | 0.289 | 1.9316 | 2.0045 | 0 | 0 | 0.037 | 0.10 | 4 | 3 | 4 |
| | | | PLT | 0.994 | 1.4129 | 2.0569 | 2.4769 | 1.893 | 0.384 | | | | |
| 26 | TSETTL | 0.9971 | CAP | 0.338 | 0.3926 | 0.3115 | 0 | 0 | -0.233 | #DIV/0! | 4 | | 4 |
| | | | ZSP | 0.987 | 0.5981 | 0.1167 | 0 | 0 | -2.465 | #DIV/0! | 1 | | 1 |
| | | | LONSNS | 0.175 | 0.3375 | 0.37 | 0 | 0 | 0.092 | #DIV/0! | 4 | | 4 |
| | | | PLT | 0.990 | 0 | 0.2469 | 0.9375 | 0.2692 | 0.000 | | | | |
| 36 | PS | 0.9999 | CAP | 0.989 | -38.116 | -45.497 | 0 | 0 | -0.178 | 0.13 | 3 | 3 | 4 |
| | | | ZSP | 0.907 | -39.089 | -44.287 | 0 | 0 | -0.125 | 0.09 | 3 | 3 | 4 |
| | | | LONSNS | 0.298 | -42.264 | -41.147 | 0 | 0 | 0.027 | 0.02 | 4 | 3 | 4 |
| | | | PLT | 1.000 | -22.263 | -69.509 | -3.4285 | -60.893 | -1.401 | | | | |
| 37 | ENERGY | 0.9999 | CAP | 0.056 | -194.99 | -196.02 | 0 | 0 | -0.005 | 0.01 | 4 | 3 | 4 |
| | | | ZSP | 0.859 | -206.7 | -184.71 | 0 | 0 | 0.113 | 0.12 | 4 | 3 | 4 |
| | | | LONSNS | 0.130 | -194.58 | -196.52 | 0 | 0 | -0.010 | 0.01 | 4 | 3 | 4 |
| | | | PLT | 1.000 | -117.1 | -265.33 | -154.39 | -219.86 | -0.912 | | | | |
| 38 | VDOTMX | 0.9999 | CAP | 0.461 | -6.7838 | -6.6737 | 0 | 0 | 0.016 | 0.07 | 4 | 3 | 4 |
| | | | ZSP | 0.999 | -7.0614 | -6.4104 | 0 | 0 | 0.097 | 0.40 | 4 | 3 | 4 |
| | | | LONSNS | 0.693 | -6.8219 | -6.6267 | 0 | 0 | 0.029 | 0.12 | 4 | 3 | 4 |
| | | | PLT | 1.000 | -5.8235 | -7.4038 | -6.0408 | -7.3729 | -0.242 | | | | |
| 39 | DELV | 0.9999 | CAP | 0.728 | -13.443 | -12.587 | 0 | 0 | 0.066 | 0.11 | 4 | 3 | 4 |
| | | | ZSP | 0.888 | -13.683 | -12.387 | 0 | 0 | 0.100 | 0.16 | 4 | 3 | 4 |
| | | | LONSNS | 0.065 | -13.057 | -12.984 | 0 | 0 | 0.006 | 0.0[illegible] | 4 | 3 | 4 |
| | | | PLT | 1.000 | -8.5857 | -15.219 | -12.939 | -14.492 | -0.604 | | | | |
| 42 | LONRMS | 0.9999 | CAP | 0.936 | 1.1184 | 0.9596 | 0 | 0 | -0.154 | 0.67 | 3 | 3 | 4 |
| | | | ZSP | 0.998 | 1.1844 | 0.902 | 0 | 0 | -0.276 | 1.21 | 2 | 2 | 3 |
| | | | LONSNS | 0.986 | 1.1432 | 0.9255 | 0 | 0 | -0.213 | 0.93 | 2 | 3 | 4 |
| | | | PLT | 0.977 | 0.8724 | 1.0944 | 0.9178 | 1.2426 | 0.229 | | | | |
| 44 | ELEVRMS | 0.9975 | CAP | 0.057 | 1.152 | 1.1599 | 0 | 0 | 0.007 | 0.02 | 4 | 3 | 4 |
| | | | ZSP | 0.992 | 1.3161 | 1.0015 | 0 | 0 | -0.277 | 0.93 | 2 | 3 | 4 |
| | | | LONSNS | 0.591 | 1.115 | 1.2016 | 0 | 0 | 0.075 | 0.25 | 4 | 3 | 4 |
| | | | PLT | 0.999 | 0.812 | 1.0891 | 1.5382 | 1.2025 | 0.298 | | | | |
| 49 | CHR | 0.7133 | CAP | 0.322 | 3.5 | 3.75 | 0 | 0 | 0.069 | #DIV/0! | 4 | | 4 |
| | | | ZSP | 0.911 | 4.25 | 3 | 0 | 0 | -0.355 | #DIV/0! | 2 | | 2 |
| | | | LONSNS | 0.322 | 3.5 | 3.75 | 0 | 0 | 0.069 | #DIV/0! | 4 | | 4 |
| | | | PLT | -999.000 | 3.75 | 0 | 0 | 3.5 | 0.000 | | | | |

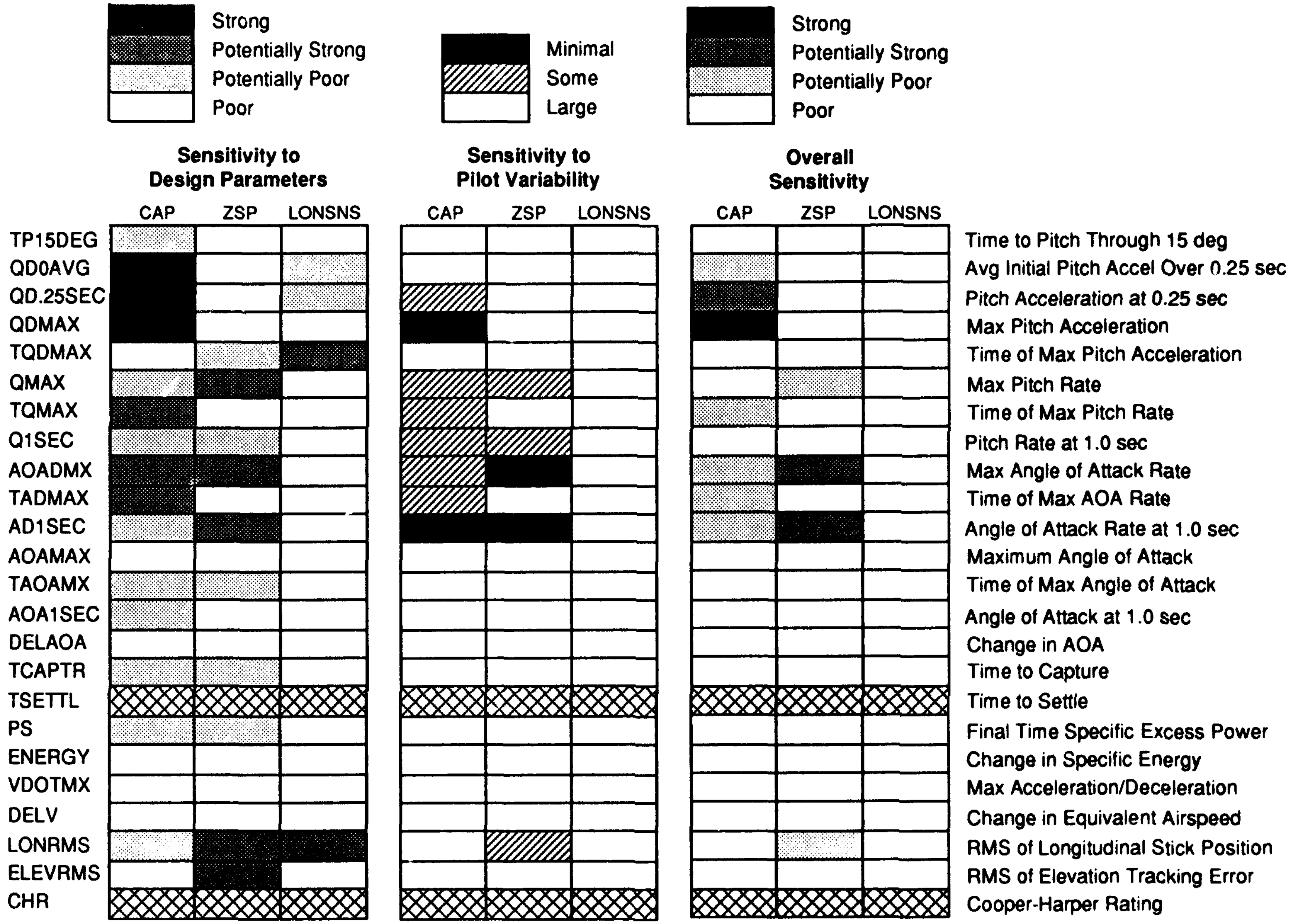
STEM 7 TEST 7 ANALYSIS F



STEM 7 TEST 7 ANALYSIS F



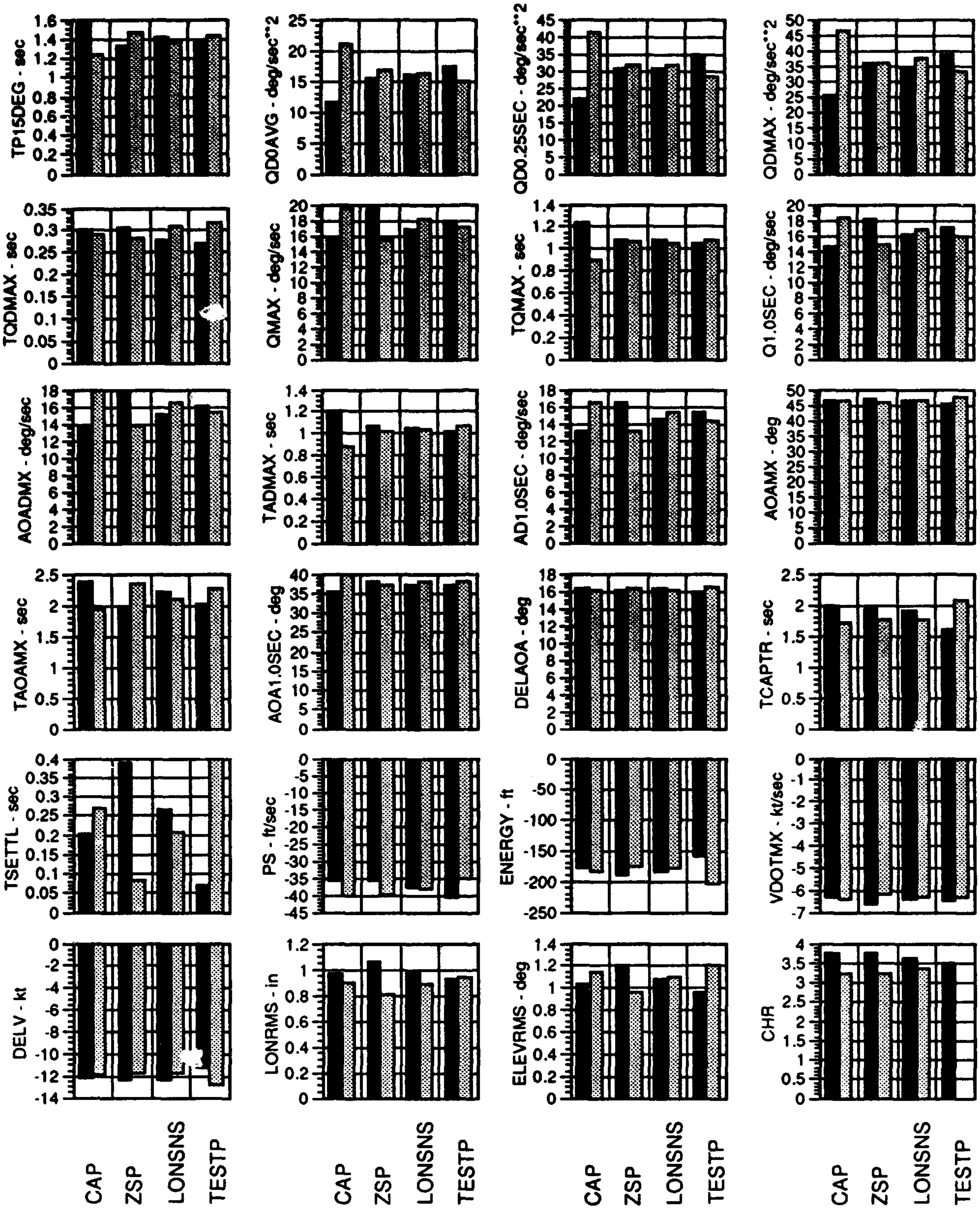
STEM 7 TEST 7 ANALYSIS F



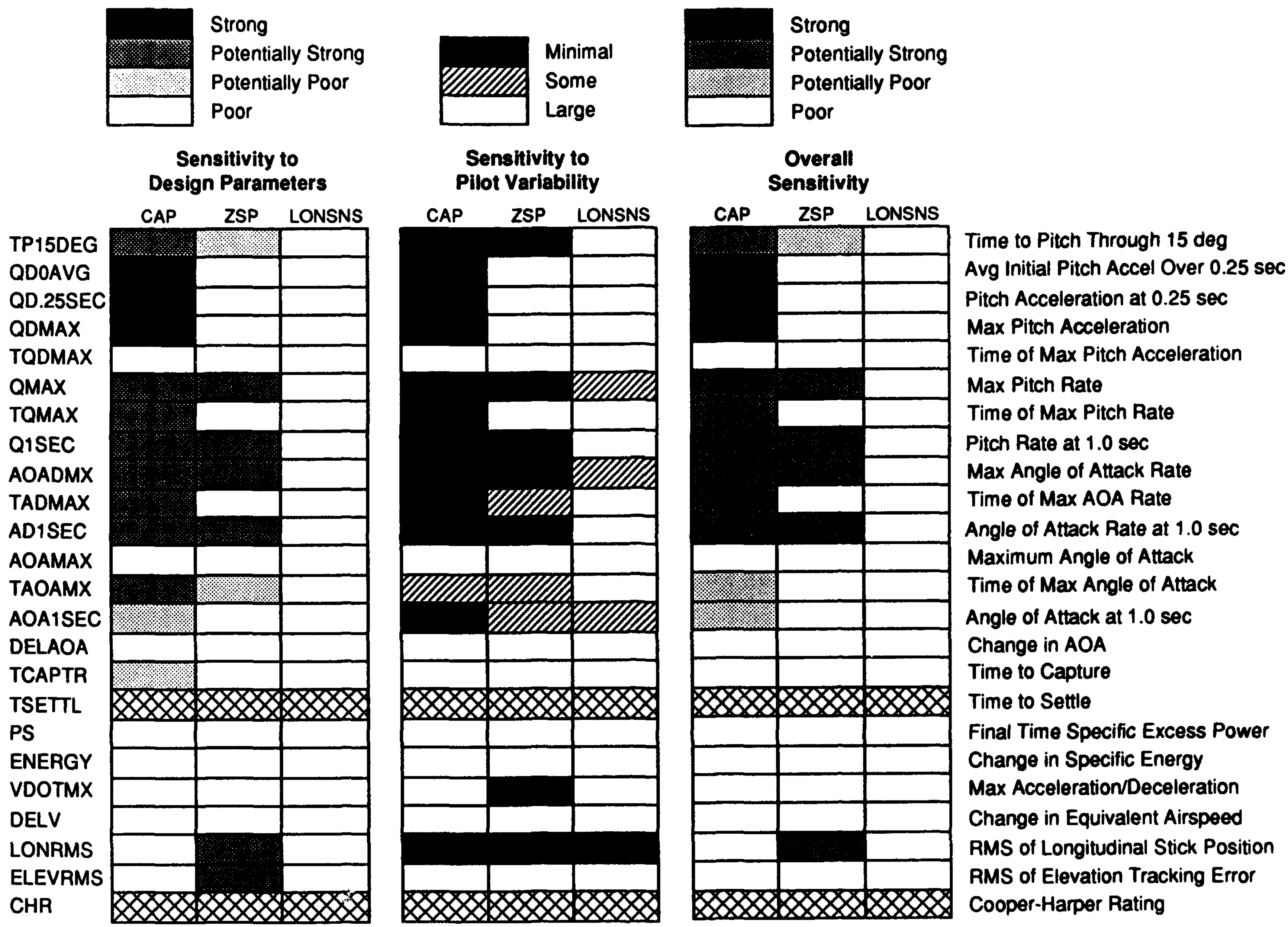
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | TPXDEG | 0.9999 | CAP | 1.000 | 1.5535 | 1.235 | 0 | 0 | -0.231 | 5.32 | 2 | 1 | 2 |
| | (15 deg) | | ZSP | 1.000 | 1.3203 | 1.4744 | 0 | 0 | 0.111 | 2.54 | 3 | 1 | 3 |
| | | | LONSNS | 0.970 | 1.4239 | 1.3697 | 0 | 0 | -0.039 | 0.89 | 4 | 3 | 4 |
| | | | PT | 0.967 | 1.3664 | 1.4271 | 0 | 0 | 0.043 | | | | |
| 4 | QD0AVG | 0.9999 | CAP | 1.000 | 11.529 | 20.927 | 0 | 0 | 0.632 | 4.24 | 1 | 1 | 1 |
| | (0.25 sec) | | ZSP | 0.585 | 15.412 | 16.861 | 0 | 0 | 0.090 | 0.60 | 4 | 3 | 4 |
| | | | LONSNS | 0.182 | 16.079 | 16.196 | 0 | 0 | 0.007 | 0.05 | 4 | 3 | 4 |
| | | | PT | 0.949 | 17.357 | 14.963 | 0 | 0 | -0.149 | | | | |
| 5 | QDXSEC | 0.9999 | CAP | 1.000 | 21.861 | 41.19 | 0 | 0 | 0.677 | 3.26 | 1 | 1 | 1 |
| | (0.25 sec) | | ZSP | 0.147 | 30.802 | 31.869 | 0 | 0 | 0.034 | 0.16 | 4 | 3 | 4 |
| | | | LONSNS | 0.536 | 30.924 | 31.764 | 0 | 0 | 0.027 | 0.13 | 4 | 3 | 4 |
| | | | PT | 1.000 | 34.62 | 28.178 | 0 | 0 | -0.207 | | | | |
| 6 | QDMAX | 0.9999 | CAP | 1.000 | 25.598 | 46.639 | 0 | 0 | 0.637 | 4.05 | 1 | 1 | 1 |
| | | | ZSP | 0.312 | 35.721 | 36.103 | 0 | 0 | 0.011 | 0.07 | 4 | 3 | 4 |
| | | | LONSNS | 0.999 | 34.325 | 37.563 | 0 | 0 | 0.090 | 0.57 | 4 | 3 | 4 |
| | | | PT | 1.000 | 38.775 | 33.159 | 0 | 0 | -0.157 | | | | |
| 7 | TQDMAX | 0.9941 | CAP | 0.434 | 0.3005 | 0.2889 | 0 | 0 | -0.039 | 0.26 | 4 | 3 | 4 |
| | | | ZSP | 0.700 | 0.3056 | 0.2841 | 0 | 0 | -0.073 | 0.48 | 4 | 3 | 4 |
| | | | LONSNS | 0.871 | 0.2796 | 0.3107 | 0 | 0 | 0.106 | 0.70 | 4 | 3 | 4 |
| | | | PT | 0.974 | 0.2724 | 0.3165 | 0 | 0 | 0.151 | | | | |
| 8 | QMAX | 0.9999 | CAP | 1.000 | 15.471 | 19.572 | 0 | 0 | 0.237 | 4.40 | 2 | 1 | 2 |
| | | | ZSP | 1.000 | 19.527 | 15.435 | 0 | 0 | -0.237 | 4.40 | 2 | 1 | 2 |
| | | | LONSNS | 0.999 | 16.838 | 18.15 | 0 | 0 | 0.075 | 1.39 | 4 | 2 | 4 |
| | | | PT | 0.947 | 17.962 | 17.019 | 0 | 0 | -0.054 | | | | |
| 9 | TQMAX | 0.9999 | CAP | 1.000 | 1.2438 | 0.8939 | 0 | 0 | -0.336 | 11.52 | 2 | 1 | 2 |
| | | | ZSP | 0.288 | 1.084 | 1.0606 | 0 | 0 | -0.022 | 0.75 | 4 | 3 | 4 |
| | | | LONSNS | 0.846 | 1.0873 | 1.0567 | 0 | 0 | -0.029 | 0.98 | 4 | 3 | 4 |
| | | | PT | 0.851 | 1.0564 | 1.0877 | 0 | 0 | 0.029 | | | | |
| 10 | QXSEC | 0.9999 | CAP | 1.000 | 14.686 | 18.327 | 0 | 0 | 0.223 | 3.34 | 2 | 1 | 2 |
| | (1.0 sec) | | ZSP | 1.000 | 18.225 | 14.716 | 0 | 0 | -0.215 | 3.22 | 2 | 1 | 2 |
| | | | LONSNS | 0.943 | 16.082 | 16.875 | 0 | 0 | 0.048 | 0.72 | 4 | 3 | 4 |
| | | | PT | 0.973 | 17.032 | 15.931 | 0 | 0 | -0.067 | | | | |
| 11 | AOADMX | 0.9999 | CAP | 1.000 | 13.739 | 17.86 | 0 | 0 | 0.265 | 4.76 | 2 | 1 | 2 |
| | | | ZSP | 1.000 | 17.763 | 13.756 | 0 | 0 | -0.258 | 4.64 | 2 | 1 | 2 |
| | | | LONSNS | 0.998 | 15.107 | 16.439 | 0 | 0 | 0.085 | 1.52 | 4 | 2 | 4 |
| | | | PT | 0.915 | 16.207 | 15.329 | 0 | 0 | -0.056 | | | | |
| 12 | TADMAX | 0.9999 | CAP | 1.000 | 1.214 | 0.8759 | 0 | 0 | -0.332 | 8.09 | 2 | 1 | 2 |
| | | | ZSP | 0.898 | 1.0752 | 1.0214 | 0 | 0 | -0.051 | 1.25 | 4 | 2 | 4 |
| | | | LONSNS | 0.767 | 1.0594 | 1.0367 | 0 | 0 | -0.022 | 0.53 | 4 | 3 | 4 |
| | | | PT | 0.959 | 1.0264 | 1.0694 | 0 | 0 | 0.041 | | | | |
| 13 | ADXSEC | 0.9999 | CAP | 1.000 | 13.161 | 16.55 | 0 | 0 | 0.231 | 3.64 | 2 | 1 | 2 |
| | (1.0 sec) | | ZSP | 1.000 | 16.589 | 13.055 | 0 | 0 | -0.242 | 3.81 | 2 | 1 | 2 |
| | | | LONSNS | 0.934 | 14.43 | 15.229 | 0 | 0 | 0.054 | 0.85 | 4 | 3 | 4 |
| | | | PT | 0.928 | 15.302 | 14.361 | 0 | 0 | -0.063 | | | | |
| 20 | AOAMX | 0.9993 | CAP | 0.778 | 46.208 | 46.736 | 0 | 0 | 0.011 | 0.29 | 4 | 3 | 4 |
| | | | ZSP | 0.998 | 47.131 | 45.801 | 0 | 0 | -0.029 | 0.72 | 4 | 3 | 4 |
| | | | LONSNS | 0.199 | 46.525 | 46.405 | 0 | 0 | -0.003 | 0.07 | 4 | 3 | 4 |
| | | | PT | 1.000 | 45.529 | 47.368 | 0 | 0 | 0.040 | | | | |
| 21 | TAOAMX | 0.9999 | CAP | 1.000 | 2.3727 | 1.929 | 0 | 0 | -0.209 | 1.74 | 2 | 2 | 3 |
| | | | ZSP | 1.000 | 1.9615 | 2.3489 | 0 | 0 | 0.181 | 1.51 | 3 | 2 | 4 |
| | | | LONSNS | 0.782 | 2.2085 | 2.0998 | 0 | 0 | -0.050 | 0.42 | 4 | 3 | 4 |
| | | | PT | 0.989 | 2.0244 | 2.281 | 0 | 0 | 0.120 | | | | |
| 22 | AOAXSEC | 0.9999 | CAP | 1.000 | 35.225 | 39.981 | 0 | 0 | 0.127 | 6.86 | 3 | 1 | 3 |
| | (1.0 sec) | | ZSP | 0.987 | 38.083 | 37.03 | 0 | 0 | -0.028 | 1.51 | 4 | 2 | 4 |
| | | | LONSNS | 0.945 | 37.136 | 37.994 | 0 | 0 | 0.023 | 1.23 | 4 | 2 | 4 |
| | | | PT | 0.822 | 37.202 | 37.897 | 0 | 0 | 0.019 | | | | |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23 | DELAOA | 0.821 | CAP | 0.423 | 16.39 | 16.122 | 0 | 0 | -0.016 | 0.39 | 4 | 3 | 4 |
| | | | ZSP | 0.285 | 16.177 | 16.341 | 0 | 0 | 0.010 | 0.24 | 4 | 3 | 4 |
| | | | LONSNS | 0.142 | 16.298 | 16.218 | 0 | 0 | -0.005 | 0.12 | 4 | 3 | 4 |
| | | | PT | 0.847 | 15.907 | 16.598 | 0 | 0 | 0.043 | | | | |
| 25 | TCAPTR | 0.9995 | CAP | 0.977 | 1.9852 | 1.699 | 0 | 0 | -0.156 | 0.63 | 3 | 3 | 4 |
| | | | ZSP | 0.744 | 1.9213 | 1.7685 | 0 | 0 | -0.083 | 0.33 | 4 | 3 | 4 |
| | | | LONSNS | 0.749 | 1.9123 | 1.7748 | 0 | 0 | -0.075 | 0.30 | 4 | 3 | 4 |
| | | | PT | 1.000 | 1.6144 | 2.0665 | 0 | 0 | 0.249 | | | | |
| 26 | TSETTL | 0.9628 | CAP | 0.388 | 0.2039 | 0.27 | 0 | 0 | 0.285 | 0.10 | 4 | 3 | 4 |
| | | | ZSP | 0.981 | 0.3902 | 0.0824 | 0 | 0 | -2.263 | 0.83 | 1 | 3 | 3 |
| | | | LONSNS | 0.343 | 0.2654 | 0.206 | 0 | 0 | -0.256 | 0.09 | 4 | 3 | 4 |
| | | | PT | 0.989 | 0.07 | 0.3962 | 0 | 0 | 2.741 | | | | |
| 36 | PS | 0.0898 | CAP | 0.592 | -35.727 | -40.152 | 0 | 0 | -0.117 | 0.79 | 4 | 3 | 4 |
| | | | ZSP | 0.526 | -35.898 | -39.895 | 0 | 0 | -0.106 | 0.72 | 4 | 3 | 4 |
| | | | LONSNS | 0.050 | -37.773 | -38.025 | 0 | 0 | -0.007 | 0.05 | 4 | 3 | 4 |
| | | | PT | 0.722 | -40.738 | -35.164 | 0 | 0 | 0.148 | | | | |
| 37 | ENERGY | 0.875 | CAP | 0.399 | -178.52 | -185.62 | 0 | 0 | -0.039 | 0.16 | 4 | 3 | 4 |
| | | | ZSP | 0.712 | -189.07 | -174.93 | 0 | 0 | 0.078 | 0.31 | 4 | 3 | 4 |
| | | | LONSNS | 0.384 | -185.41 | -178.45 | 0 | 0 | 0.038 | 0.15 | 4 | 3 | 4 |
| | | | PT | 0.999 | -159.29 | -203.84 | 0 | 0 | -0.249 | | | | |
| 38 | VDOTMX | 0.9964 | CAP | 0.314 | -6.3674 | -6.4366 | 0 | 0 | -0.011 | 0.33 | 4 | 3 | 4 |
| | | | ZSP | 0.995 | -6.6476 | -6.155 | 0 | 0 | 0.077 | 2.35 | 4 | 1 | 4 |
| | | | LONSNS | 0.292 | -6.4337 | -6.3676 | 0 | 0 | 0.010 | 0.31 | 4 | 3 | 4 |
| | | | PT | 0.741 | -6.5085 | -6.2982 | 0 | 0 | 0.033 | | | | |
| 39 | DELV | 0.9812 | CAP | 0.383 | -12.175 | -11.855 | 0 | 0 | 0.027 | 0.21 | 4 | 3 | 4 |
| | | | ZSP | 0.707 | -12.361 | -11.676 | 0 | 0 | 0.057 | 0.44 | 4 | 3 | 4 |
| | | | LONSNS | 0.684 | -12.33 | -11.694 | 0 | 0 | 0.053 | 0.41 | 4 | 3 | 4 |
| | | | PT | 0.984 | -11.23 | -12.776 | 0 | 0 | -0.129 | | | | |
| 42 | LONRMS | 0.9268 | CAP | 0.608 | 0.9749 | 0.898 | 0 | 0 | -0.082 | 5.11 | 4 | 1 | 4 |
| | | | ZSP | 0.995 | 1.0671 | 0.8073 | 0 | 0 | -0.283 | 17.53 | 2 | 1 | 2 |
| | | | LONSNS | 0.744 | 0.9867 | 0.8857 | 0 | 0 | -0.108 | 6.71 | 4 | 1 | 4 |
| | | | PT | 0.216 | 0.9295 | 0.9446 | 0 | 0 | 0.016 | | | | |
| 44 | ELEVRMS | 0.969 | CAP | 0.812 | 1.0329 | 1.1436 | 0 | 0 | 0.102 | 0.42 | 4 | 3 | 4 |
| | | | ZSP | 0.996 | 1.2093 | 0.965 | 0 | 0 | -0.228 | 0.94 | 2 | 3 | 4 |
| | | | LONSNS | 0.194 | 1.0783 | 1.0964 | 0 | 0 | 0.017 | 0.07 | 4 | 3 | 4 |
| | | | PT | 0.998 | 0.9547 | 1.2145 | 0 | 0 | 0.243 | | | | |
| 49 | CHR | 0.4653 | CAP | 0.668 | 3.75 | 3.25 | 0 | 0 | -0.144 | #DIV/0! | 4 | | 4 |
| | | | ZSP | 0.668 | 3.75 | 3.25 | 0 | 0 | -0.144 | #DIV/0! | 4 | | 4 |
| | | | LONSNS | 0.378 | 3.625 | 3.375 | 0 | 0 | -0.072 | #DIV/0! | 4 | | 4 |
| | | | PT | -999.000 | 3.5 | 0 | 0 | 0 | 0.000 | | | | |

STEM 7 TEST 7 ANALYSIS G



STEM 7 TEST 7 ANALYSIS G



STEM 7 TEST 7
PILOT A
LONGITUDINAL CONFIGURATION 131
LATERAL CONFIGURATION 2
CHR 4
PIO 2

This would be a difficult airplane to track with. The pitch response is sluggish and prone to overshoots. It gives a longitudinal springy feeling. I have trouble even capturing a thirty degree pitch attitude to start the maneuver. It's always bouncing plus or minus a degree until I really fine tune it. I can make it happen fast but it's a high gain closed loop task to get him inside of my desired bars which is still nowhere near a guns tracking solution. It would be okay for missile acquisition but it would be lousy for guns tracking. The technique I'm using is full aft stick, pause a very brief period there, and then release the stick to get the rate stopped and then load the stick back up again to stop where I want. And it's really taking some lead shaping of my stick inputs in order to make this thing work quickly. And it's only because I've practiced this exact maneuver fifteen times here that I can make it happen fast. The natural tendency is to overshoot longitudinally both directions and get outside desired criteria. It takes a fair workload to make it happen and hold desired criteria. The initial rate is a little bit slow, such that I'm having to go full aft stick and hold it. Then the end game handling characteristics are poor in that it has a tendency to swing past and overshoot unpredictably. I can solve these problems but I have to work hard to do it. Is it controllable? Yes. I always got desired performance but it is not satisfactory without improvement. It required moderate pilot compensation. I really have to be used to it. I have to do it right. The deficiencies are annoying. Now I can still get up there in a desired amount of time but I have to work at it. I'm what's making it happen. The airplane is not doing a good job of it for me. PIO rating? There is a tendency for PIO if I'm driving it and I don't do it just right then I'll swing past it one way and then I have to get myself into the correct phase in order to kill it. The motions can be eliminated by pilot technique. But it takes some work and that's why we have a CHR 4 out of this airplane. Too sluggish and tendency to overshoot.

STEM 7 TEST 7
PILOT E
LONGITUDINAL CONFIGURATION 131
LATERAL CONFIGURATION 2

This one has good initial dynamics and it stops pretty quickly. There is an overshoot. You have to lead it a little bit on the stop. You can't let it get within two degrees before you begin to reverse the input, but it will stop rather quickly once you counter the pitch rate. So pretty good dynamics on the pitch capture. Sometimes we may overshoot it and sometimes we may not, and so it's probably going to make a big difference in your capture times. Basically, it has good dynamics and it stops quickly when you counter the pitch rate. It's pretty desirable combination there, I think.

STEM 7 TEST 7
PILOT F
LONGITUDINAL CONFIGURATION 131
LATERAL CONFIGURATION 2

This nose is extremely heavy, very slow acceleration rate and once it builds up it appears to be very hard to stop it, or there's a lot of inertia...The flight control capability to decelerate the pitch once the rate builds up is not very good. What I'm doing to compensate for the flight control system from a piloting point of view is I'm really going max deflection to get this rate started and then leading the deceleration based on what I've seen the last two runs so that I get capture. I'm backing off well before the pipper gets to the target so that I can stop it. If I keep the deflection in to try to get the pitch rate built up and hold it too long, I can't stop it on the target. So the deceleration characteristics of the flight control system are really poor. They are very sluggish and they seem to be a little bit delayed for your normal pilot demand response time. Very poor in pitch response. Both in onset rate and deceleration capability. It is very sluggish, non responsive for a fighter type aircraft.

STEM 7 TEST 7
PILOT G
LONGITUDINAL CONFIGURATION 131
LATERAL CONFIGURATION 2
CHR 4
PIO -

It seems like a more stable pipper. A little sluggish initially but then really takes off. It has a very slow initial reaction, but then you get a good response which makes it hard to predict. So not quite as predictable. It's a good stable initially, but then it really takes off. There is a tendency to overshoot initially. I will try to be a little less aggressive. It is definitely controllable by being more open loop, but not as quick. It's very time critical. If you get one overshoot, chances are you are going to get two. During the tracking it's a matter of timing when to come off the back pressure. Once you come off it's fairly easy to hold the target in place. It's pretty quick. Is it controllable? Yes it is controllable. Is adequate performance attainable with a tolerable pilot work load? I would say that is correct. Is it satisfactory without improvement? No, I do not think it is. Desired performance requires moderate pilot compensation. I would say that's true. It seems like the difficulty is in predictability of when to release the back pressure to keep the target within the reticle and not overshoot. The tendency is if you overshoot once you are going to overshoot again. If you can prevent the first overshoot, well then you can pretty much keep it there right away. Overall response as far as quickness - it's pretty quick although you can easily use full aft stick to get it there, so you are waiting for the airplane to get up there. It seems like we probably do reach a max pitch rate on the way up there.

STEM 7 TEST 7
PILOT E
LONGITUDINAL CONFIGURATION 132
LATERAL CONFIGURATION 2

Okay, good initial pitch rate on that one, but there is a lot of overshoot. Potentially I have to lead it a lot, and it's not real predictable exactly how far you have to lead it. I'm probably going to have to sneak up on this one. I won't be able to use full back stick like we did on the last one (longitudinal configuration 131). This one is much less predictable. It has a quicker initial pitch rate, but then it is more difficult to stop for the tracking task. It stops very quickly, but there is a tendency to overshoot. I haven't been able to do it yet in about three tries without overshooting or undershooting. The quickest way to do it is just to sneak it on up there - use about half your pitch control, and then just relax pressure when you want to stop it. It would be pretty difficult to track using those dynamics. Okay, what I'm doing is using about half pitch control and nursing the pipper up to the target and trying to stop it. To stop you don't really have to counter the pitch, you just kind of relax the back stick. I tried to stop it a little too aggressively on that one, and I undershot. You have to be real careful to relax pressure and not aggressively counter the pitch rate. This one has better open loop response, better initial pitch rate, but it's very sensitive on stopping the pitch exactly where you want it for this task with a fairly short span of pitch. You are going to have to kind of sneak up on it, and then just relax the back stick. Don't aggressively counter it to try to capture. It is less predictable and results in a more difficult task than the last one, although it's probably not much slower.

STEM 7 TEST 7
PILOT G
LONGITUDINAL CONFIGURATION 132
LATERAL CONFIGURATION 2
CHR 5
PIO -

I have lots of overshoots on this one. Not bad when you run out of air speed though. Then you lose all your sensitivity. I'm a little stick limited on this one as far as getting the nose up there. It is much more easy to control the oscillations at the slower air speeds, but it's rather slow to track up there. It's very jerky as far as trying to track. It is very controllable if you are slow and smooth. Part of that might be, like I said, as you lose air speed it gets more controllable, not quite as pitch sensitive. Now when I tried a combination of a quick pull with an early lead, the difficulty is in tracking and stopping the point inside the circle. It is easy to get in a PIO. But once you back off and go open loop it's pretty stable. So you can get your initial pull and then back off open loop as it reaches the circle and you'll be able to track it. I'm using a technique to test the flyability of the maneuver. It's not too difficult to set up for additional captures. I'll just dump the nose, pick up extra air speed, and the reset my high pitch attitude and let the air speed bleed off. Then as long as I'm within the data band of altitude, I will begin the maneuver. As I bleed out the air speed I've been leaving the throttle fixed. The power is set a little bit higher than for thrust for level flight, but it allows it to bleed off when you get to the 30 degree nose high pitch. This configuration is all a matter of timing of when to lead, when to release the pressure and to go very open loop as you

track the target. If you go closed loop you are going to PIO. In that respect you could say it's not very predictable as far as when you need to do your lead. I really want to back out of this configuration. I am flying this by a pull, hold back, relax back pressure, they come in with maybe another inch of back pressure to hold it in the reticle. If you don't have the right lead to come off the back pressure you are going to overshoot, or if you're late to come back in with your mild back pressure, or come in with too much you are going to overshoot. This configuration really tries to get the pilot to back out on the loop to be successful. It is definitely controllable. Adequate performance attainable with a tolerable pilot work load? Yes. Satisfactory without improvement? No. Adequate performance requires considerable pilot compensation because of the compensation required to prevent the overshoots is not very predictable, not quite as predictable as the previous (longitudinal configuration 131), and there is a real tendency to go back and forth if you don't get the lead point just right.

STEM 7 TEST 7
PILOT E
LONGITUDINAL CONFIGURATION 133
LATERAL CONFIGURATION 2

Pretty sluggish initial response on that one. You can certainly use full back stick and hold it for a good while. And then you have to aggressively counter it. There seems to be a lot of momentum on the nose there. It wants to keep going if you don't aggressively counter the nose up pitch to stop it where you want. This is a very easy capture if you just aggressively counter the nose pitch. I believe we have probably reached maximum pitch rate before we start the capture on this configuration. It will stop just about where you want it to stop with little bobbling if you just aggressively counter the pitch. And you can wait until it is well within your two degree limit here on pitch before you stop it. Very little problem stopping it. That one is fairly slow, sluggish, initial pitch with good dynamics at the capture.

STEM 7 TEST 7
PILOT G
LONGITUDINAL CONFIGURATION 133
LATERAL CONFIGURATION 2
CHR 5
PIO -

This one seems very stable, very controllable. It is very sluggish, and now we are getting to the point where I'm waiting on the airplane to get there. It doesn't seem like very much lead is required. It's a slow pitch. I can track things pretty precisely. Once the thing hits the reticle there is no lead time required at all. The 80 mils gives you plenty of time to freeze the target within the reticle. I am feeling a little bit pitch limited. I like the airplane's tracking capability. I just go full aft stick, there is the target, don't even have to worry about overshooting. There is not a lot of technique involved in this one. It's just point and shoot. The problem with this configuration is its sluggishness. It's a slow pitch rate capability. Yyou can pretty much wait until it hits the reticle and just relax the back pressure, very little movement is required, and you can still go pretty open loop as far as tracking. I imagine you can be closed loop too. It doesn't look like

moving the stick very much is going to do anything with small inputs. Yes it is very controllable. Adequate performance? Yes, there is virtually no work load. Satisfactory without improvement? No, the only problem that keeps it from being satisfactory is the length of time. Now we are talking not so much control of the airplane as we are the amount of time it takes to achieve the parameters. So I'm going to say it does warrant improvement. It's not a pilot compensation thing, it's more airplane performance, it's not so much a flying quality problem in terms of pilot compensation. I think it falls in the moderately objectionable deficiency because I don't think you can capture it within a desired time. It might be interesting to look at how much time it was taking me on the previous examples versus this example. It may not have been that much difference, but I think just the response of the airplane makes the pilot feel like it is taking a much longer time to get to the target. The others might have been quicker in responding, but they were more difficult to track.

STEM 7 TEST 7
PILOT A
LONGITUDINAL CONFIGURATION 134
LATERAL CONFIGURATION 2
CHR 3
PIO 2

This configuration is a little quicker. It takes me from that threshold from a CHR 4 to a 3. But the end game is slightly less predictable, it tends to stop a little bit abruptly when I release the stick but it is very easy to compensate for. It really just sits there when I do it right. Just one predictable stick pulse and the nose stops where I want. I would prefer if I had slightly more performance out of the aircraft, but not bad. I go to full aft stick, I release the stick, I'm on the target. It's pretty nice. It would be nice if I didn't have to use a full control deflection to get a twenty degree pitch change. But then again I'm trying to drive it to maximum speed. That was pretty good that time but again I'm having to go to full stick to make it happen. I wouldn't want the nose to get up there too much faster than that. If the nose got up faster then I'd have a lot of trouble capturing. Controllable? Yes. Adequate? Yes. And it's satisfactory without improvement. Minimal pilot compensation is required with a mildly unpleasant deficiency. I don't like having to hold the full stick for a minute, then release. It would be nice if the nose come up a little faster so that I didn't need the full stick control. And because I'm coming off of a full control deflection, it makes the prediction of the end point a little bit of a problem. Pretty natural though. I have only minimal problems with that. It's not negligible deficiencies, it's a mildly unpleasant deficiency, in that I have to go to full aft stick. But the rate is good and the handling qualities are good. PIO rating? Very minor and easy to get rid of. Pretty nice all around configuration. Could be slightly quicker.

STEM 7 TEST 7
PILOT E
LONGITUDINAL CONFIGURATION 134
LATERAL CONFIGURATION 2

This one is a little bit quicker initial pitch rate (than longitudinal configuration 133). Not much quicker, just a little, and then it's a little less predictable on the capture on the high end. I can wait a

little longer to counter the pitch on this one. It stops almost immediately when you counter the pitch, but then there will be a little bit of a tendency to bobble out of it. A little more sensitive in pitch at the tracking end. So I have to counter the pitch a couple of different times. I'm aggressively pulling full back stick to get the pitch rate started. I'm waiting until the target basically hits the pipper before I try to counter it, and then I counter it pretty aggressively to stop the pitch, and then I'm going to have to make secondary corrections to keep it within the band or it will want to bobble out again. It would be a good one for PIO I think. Maybe a little bit more work to track with this configuration than with the last one. Once you get use to it, it's not too difficult though for this particular capture task. As I get more practice with this I like it better. The capture is very responsive. It stops very quickly when you counter it, and you have to be ready to come back and put further corrections in. It is fairly controllable with a little practice. I'm using full back stick on this, and them I'm countering it fairly aggressively, but I'm waiting until it's already well within the 80 mil circle before I'm countering. I have to be ready for a second counter rather quickly and fine tune the tracking to keep it within the tolerance. That shows I can't fly and talk at the same time. This has a good initial response and stops very quickly on the tracking end of it, although it would take a little getting use to for the tracking task. You can be pretty aggressive on it at both ends, but you have to dampen out your corrections on the tracking task very quickly or it will get into PIO pretty easily. Overall, pretty good.

STEM 7 TEST 7
PILOT F
LONGITUDINAL CONFIGURATION 134
LATERAL CONFIGURATION 2

This one feels a lot like a conventional airplane. This one feels like an F-15 to me a little bit. The onset rate is rapid. The stick is not at a full aft deflection for very long and then the pitch rate seems to decelerate at a reasonable portion with the amount of aft stick that is released. It is sensitive in pitch in capture, but it is manageable. I had some bobbles right there, but the target stayed inside the reticle. So basically, you've got a nice crisp onset rate and a controllable decel rate, so it's a pretty natural release for the capture. It has a nice crisp onset rate, nice predictable release, nice predictable in the sense that it's not sluggish. It's very crisp, but it's controllable and predictable. You back off the stick force, the nose starts decelerating at the rate that the stick is coming out and it stops when you stop. So there's really no lead gaming. The nose seemed to respond pretty well to stick input.

STEM 7 TEST 7
PILOT G
LONGITUDINAL CONFIGURATION 134
LATERAL CONFIGURATION 2
CHR 3
PIO -

This one looks like it has a better initial response (than longitudinal configuration 133) though it doesn't require as much lead either. This one seems very similar to the last one, just a little more responsive, a little

quicker rate capability, but as far as the tracking task it's very similar to the other. You don't need very much lead, it's very easy to track precisely. I'm using basically the same technique as I did on the previous one. I don't feel that much difference other than it seems like a little quicker response. The airplane can move faster. But the other handling qualities are about the same. It is controllable. Easily getting adequate with tolerable pilot work load. I thought it was pretty good. Really the only difference between this and the last one is the rate of response initially it seems like. But minimal pilot compensation required for the desired performance. There is some tracking required. It is a little more responsive when it gets inside the pipper, so you have to be a little careful with your inputs when you do get it inside the pipper, but it's nice and smooth getting the target inside of the 80 mils. The only pilot compensation really is being cautious about your inputs once you begin tracking.

STEM 7 TEST 7
PILOT E
LONGITUDINAL CONFIGURATION 135
LATERAL CONFIGURATION 4

This is kind of a slow initial response and it builds up rather rapidly, and then it's very difficult to stop. I think I am going to have to sneak up on this one. The technique to use here is to use full back stick just to get the nose started because it's so slow getting started moving up. And then once it does get started, start feeding out the back pressure to slow the rate down so that it's controllable for the tracking task. I think that will work best. There seems to be a fair amount of lag in the tracking end of it, so it's very difficult to track with. It will overshoot pretty easily. I'll try being a little more aggressive here a couple of times and see if I can get it to stop. That was fairly reasonable, but it's really a matter of timing to be able to stop at just the right point. What I'm finally doing now is being fairly aggressive with it but starting to feed out the back stick fairly early. So there is a lot of pilot compensation on that. Rather difficult from the tracking end of it, and it's also sluggish getting the pitch rate started. So all together it's kind of undesirable tracking, undesirable control traits there. The final rate on the pitch was pretty good, but then it got to be difficult to stop. It doesn't stop immediately when you let off. It seems to overshoot a little bit.

STEM 7 TEST 7
PILOT G
LONGITUDINAL CONFIGURATION 135
LATERAL CONFIGURATION 4
CHR 5
PIO -

The tracking is a problem. I have a real tendency to overshoot. It's a timing problem trying to get the timing down to both release the back pressure, then also to come back in with the back pressure so that I don't overshoot. So far in each one I have used full aft stick. A couple more looks using full aft then maybe I will take a look at it by slowly getting it up there. I think the average pilot is going to use whatever he has, which is full aft stick. You do definitely have to lead this prior to it getting to the circle. I imagine a smooth pull is going to get me better flying qualities, but you're not going to want the slow time. There is

also a feeling that you may be able to get there quicker by going slow, but that's not going to be the average pilot's reasoning. The key is timing. You definitely have to lead it prior to it reaching the circle or you are going to overshoot. So there is a fair amount of pilot compensation going on here by using the full aft stick technique to make it happen. It's aft stick, come off the aft stick, and then when I come back with the aft stick again, I even hit full aft stick on that one. So there is some large stick movements taking place to minimize the time required. It's controllable. Adequate performance is attainable with a tolerable pilot work load. Yes. It definitely warrants improvement. You can hit desired performance, but I think it requires considerable pilot compensation to do it and I'm going to go more towards the amount of compensation that is required versus the performance that's there.

STEM 7 TEST 7
PILOT A
LONGITUDINAL CONFIGURATION 136
LATERAL CONFIGURATION 2
CHR 4
PIO 3

I'm afraid to put in full aft stick. The rate comes on okay without full aft stick but I'm afraid of it because this aircraft is very prone to PIO and so I have to be very careful here to keep from exciting that PIO on the end game. The response is very quick, too quick. It feels nervous longitudinally. This would be a lousy tracking aircraft because of the jumpy nose, there is a lot of springyness to the nose when I'm attempting to get a smooth track at the end. It's always bobbling up and down. I can't settle the nose down to a smooth track, even of a basically non-maneuvering star in the sky or a target like that. There was a good example of a PIO that got me just to the limits of desired criteria. That was about as quick and smooth as I can possibly do it and that's with a bang to the backstop, an immediate release and then very quick nervous little motions on the stick to try and stop the thing dead in the middle. I managed to get away with it that time but I really have to pay attention. I have to do it right. I'm the guy who's doing it, the airplane is not naturally doing that. And unless I do it just right, it's easy to overshoot and get close to the desired limits on pitch capture. There was a more typical one where I had one overshoot almost to the bottom limit of the range and then it bounced back to the middle. And now I'm oscillating plus or minus five mils to try and track it. It's that oscillation that worries me, that if we got into a maneuvering target you'd have a heck of a time settling the nose down. It was always controllable. Yes, I hit adequate with a tolerable workload, but is it satisfactory without improvement? No. The rate is good. My complaint is in the end game, the tendency to oscillate longitudinally makes my capability to hit desired performance questionable and I have to work hard within desirable limits. It's moderate pilot compensation to get rid of the tendency towards the deficient PIO. And PIO ratings? Yes, there's a tendency, they're easily induced. They can be prevented or eliminated, but only at a sacrifice to task performance or through considerable pilot attention and effort.

STEM 7 TEST 7
PILOT E
LONGITUDINAL CONFIGURATION 136
LATERAL CONFIGURATION 4

This one has a higher pitch rate and is still difficult to stop, where the other one (longitudinal configuration 135) had a lower pitch and was difficult to stop. We are getting the most difficult from both worlds here it looks like at this point. This one stops very rapidly when you release the back stick. It seems like you have to aggressively stop the pitch when you use full back stick, and then come right back in and use a lot of back stick to hold the nose up. That's bad. Okay, I think the best way to do this one is to try to sneak up on it a little bit. It's almost dead beat. When you relax a little bit of the back pressure it just stops. But a little bit is all you need to relax and then it will go too nose down if you do anything other than relax a little. Really pretty difficult to control or predict at the capture end. If you use partial back stick and a slower pitch rate it is fairly easy to stop because it will stop quickly when you release the back pressure. So just release the back pressure a little bit and hold back pressure to keep it from dropping off again and it works pretty quickly. I think that is the quickest, most consistent way to do it. It does have pretty good open loop pitch characteristics and really has a fast pitch rate. It is just difficult to stop.

STEM 7 TEST 7
PILOT F
LONGITUDINAL CONFIGURATION 136
LATERAL CONFIGURATION 2

Very light nose. The nose is very sensitive to any stick input as far as initial pitch acceleration, but then once it's onset it doesn't seem too much different than the other configurations as far as max rate. Then as far as capture goes, the sensitivity to pitch causes a capture problem. The only trouble stopping it is just that once you stop it, the high pitch accelerations move the target around while I'm trying to track it. Might be a little pilot problem there too. I just intentionally put a lot less stick control into it once it got into the area so now I'm not inducing the short term pitch accelerations. If I just concentrate on not putting much stick input into it when I get it near the target and sort of baby the stick, it doesn't have as many oscillations. But the slightest control input is causing some pretty quick pitch accelerations. The ability to stop the nose is there for sure. Once you unload it stops, but then you have trouble stabilizing. I have a suspicion the max pitch rate in this airplane is not too much different as some other sluggish configurations. The onset rate seems high, though.

STEM 7 TEST 7
PILOT G
LONGITUDINAL CONFIGURATION 136
LATERAL CONFIGURATION 4
CHR 5
PIO -

It's pretty good tracking at 30. Good, quick response, but now I'm going to bobble around a bit. So I can't have my cake and eat it too here, a quick response and a good tracking capability. Real easy to overshoot this

configuration using large stick inputs. I will try a slower onset. It seems to take a long time to get it to work. Obviously the slower the onset, the slower I move it up there, the less difficulty I have trying to find the lead point. But it is very responsive. That's nice, but there are just some difficulties in tracking. This might be one where I might not use full aft stick to optimize everything. This is the first configuration I've not gone to full aft stick. Let me try another full aft stick but I think that's just too uncontrollable for the tracking portion unless you get real lucky. I guess I'm probably using just about 3/4 stick versus full. Then I can track it a lot quicker. Don't have to deal with those high rates that I hit the target with. Now this is definitely a situation where I think it loses some of its operational relateability because I don't think the average pilot is going to back off on the stick if he needs to get the nose up there. The big driver here is the compensation is in the form of not using the natural full control stick. It was controllable. Adequate performance was attainable with tolerable pilot workload. Satisfactory without improvement? I would say no. Very objectionable? No, not really. Moderately objectionable, adequate performance requires considerable pilot compensation. I feel like that's a considerable pilot compensation to lighten up the amount of pull you're using to get the nose up there and that's for adequate performance. I feel like if you pull full then you do get a lot of overshoots.

STEM 7 TEST 7
PILOT A
LONGITUDINAL CONFIGURATION 137
LATERAL CONFIGURATION 2
CHR 4
PIO 1

This airplane has a little bit sluggish nose response. I'm having to go full aft stick and hold it for awhile. It would be nicer if it came up a little bit quicker. It's still meeting what I call desired criteria, but I'd be happier if it was faster. And again, it's fairly predictable. I really have to overdrive it to get any PIO at all. Basically, it stops where I want. Again, the control stick movement is full aft, hold it on the stop for a little longer than I want, then I release the stick to stop the rate and then slowly load it back up again to take care of the off trim condition like (pilot F) was talking about. If I trim beforehand, I suspect it would just stop there, but it's a natural enough thing to be expecting to hold in aft stick, because I know I'm off trim at the beginning. Is it controllable? Yes. Adequate? Yes. Satisfactory without improvement? It depends. The rate is a little slow. I have to put in full aft stick. I'm going to say that's just too sluggish and it should be fixed. It still meets desired criteria, but the nose just comes up too slowly. PIO? There's really no tendency, the nose comes up very nicely. So, I like everything about this, it's just a little bit too slow and that should be fixed and if it was slightly faster, then I'd give it a CHR 3. It's almost on a border between a CHR 2 and a 3.

STEM 7 TEST 7
PILOT E
LONGITUDINAL CONFIGURATION 137
LATERAL CONFIGURATION 4

This is much slower initial pitch rate (than longitudinal configuration 136). I think we are approaching maximum pitch rate before we get to the target. I don't think the initial pitch rate is acceptable. It's pretty slow compared to some of the others, but the tracking is easy. For this one, I am using full back stick and aggressively stopping. The pitch rate is slow. We are reaching maximum pitch rate before we get to the target attitude and then it's a fairly simple manner to stop it in track. Lots of damping I would say.

STEM 7 TEST 7
PILOT F
LONGITUDINAL CONFIGURATION 137
LATERAL CONFIGURATION 2

This one seems real steady. Nose is very stable. Very sluggish and stable. I didn't do a full stick deflection on that run. But, the control is high enough I think I can ask for a higher rate and stop it. On this run I put the stick in full deflection, got the rate established and when I unloaded it, it stopped. It's very stable as far as it's slow to accelerate and it's very stable once you initialize the pitch control forces, the nose just stops. In other words it's almost as if as you have aft stick it moves at a certain rate, not that fast, and once you release it it stops pretty much where it's at. It makes the capture fairly easy and predictable and the onset rate is very slow. That time I had full stick deflection even longer. And I almost overshot it but released it later and probably had the shortest time to capture. If I'd have held the stick deflection even longer I'd have overshot the target. But it is so sluggish. To build up the rate that's desirable, you have to hold the full deflection and then when you stop it pretty much freezes on the target.

STEM 7 TEST 7
PILOT G
LONGITUDINAL CONFIGURATION 137
LATERAL CONFIGURATION 4
CHR 2
PIO -

This is feeling a little more sluggish. Larger displacements required to get up to 30. Much slower response, but very easy to track the point once you get up there. Not a lot of lead required. You can see my tracking capability at 30. Very easy. Pull full back and then just stop it right in the reticle. I don't need the big stick deflections back here. It is very stable to track with. This is definitely a rival for the last configuration (longitudinal configuration 138) if not a little bit better in my opinion. I think on this one I gave up some speed in the ability to quickly acquire the target, but I think it's made up with what I've gained in control once I get to the target. I mean look at how steady you keep that dot there. It's an excellent tracking platform without a doubt. My only complaint about this configuration might be the quickness of response. It is very predictable. Definitely controllable. Adequate performance is definitely obtainable with a tolerable pilot work load. Satisfactory

without improvement? I would say yes. The only factor involved here is the time, the quickness of the response. Pilot compensation is not a factor for the desired performance at all, but it is not excellent or highly desirable due to the slowness of the response to get the nose to track there.

STEM 7 TEST 7
PILOT E
LONGITUDINAL CONFIGURATION 138
LATERAL CONFIGURATION 4

This has a quicker pitch rate and less damping. It is going to be more difficult to stop. It's a timing task again, but I think it can probably be done fairly aggressively. You have to get right back on it after you stop it. It's difficult to track. It's a matter of getting the timing just right. A lot of pilot compensation, but the initial pitch rate is good. If you use full back stick on this one, you have to aggressively stop it and then put the back stick right back in to keep from undershooting it. If you do that, and you are lucky, it works pretty well, but it would be very difficult to track with that one. Yeah, it's almost a programmed stick routine that you have to do. Full back stick until it gets down within the reticle, then a quick pump forward to stop it and then right back on it again. So it's a little stick cycle there to try to keep it in parameters. If you do it just right it works. It has a fairly good pitch rate to begin with. Not as good as some. It is kind of an intermediate pitch rate. Not much damping at the high end, and it's a matter of timing and pilot compensation to get the tracking task down. It would take a lot of getting use to.

STEM 7 TEST 7
PILOT G
LONGITUDINAL CONFIGURATION 138
LATERAL CONFIGURATION 4
CHR 2
PIO -

I like this. Very quick response, very predictable. It's like a can stop it on a dime. Very stable. I just stick the pipper where I want it and it stops. Virtually no lead required. Of course no telling what this would feel like in motion. Pretty good unload. This is a very easy configuration to fly. Still using full aft stick. Now I'm starting to pick up a mild tendency to overshoot the plane. I can maybe lead it by a little bit more, but it is not overshooting to the extent that it's going outside of the reticle. It is definitely controllable. Adequate performance with a tolerable pilot work load? Yes. Satisfactory without improvement? I believe so. It's very responsive, it goes right up there, and I like the fact you don't have to lead it. It seems like you can come off the stick and hold it there. You do have to, like all the other configurations but not to the same extent, come back with the back pressure to keep the nose from falling off. But really I don't think it's a factor for desired performance. I think it's good. It's not excellent, but I think it's good with negligible deficiencies. Definitely my favorite configuration so far.

STEM 7 TEST 7
PILOT A
LONGITUDINAL CONFIGURATION 139
LATERAL CONFIGURATION 2
CHR 4
PIO 3

Alright, I got the quicker response I asked for. Be careful of what you ask for. I like the response but the end game is going to be a detractor. I can get the pitch response I want without a full aft stick input. When I start to release the stick, the nose bobbles almost to adequate criteria. It's going once up and once down to the limits of my desired criteria here. It is difficult to get a smooth end condition. I can compensate for this but I have to work at it a little bit. It is definitely fast. Just kind of annoying. That was a good representative one there in that I bounced right to the edge of the desired criteria as I was attempting to rush it. It's nice and fast. But because I'm trying to hurry it my nose bounces, one large and then one small overshoot and it's very difficult for me to put in just the right stick shaping to get rid of that bounce. Controllable? Yes. Adequate? Yes. Satisfactory without improvement? I doubt it. And the problem is it's a minor but annoying deficiency. I have lots of pitch rate available. If I just touch the stop, it really takes me to a rate that's about the maximum I'd want to see. My tendency in this aircraft would be to maybe touch the aft stop for this kind of task but probably not all the way to the backstop, which is a good design tradeoff. But the problem with this is predictability of the end game. If I check the stick forward at the natural moment or what the rate would indicate I should do, the nose either stops off the right position or undershoots and then bounces back up. The amplitude of the overshoot and undershoot is such that it's almost bouncing me out of desired criteria. It is very difficult to predict to get the pipper exactly on the target. So I'm hitting desired performance but my end game compensation is a moderate workload and it's an annoying deficiency. PIO rating? There is a tendency for.undesirable motions. These motions can be prevented only with sacrifice to task performance or through considerable pilot attention.

STEM 7 TEST 7
PILOT E
LONGITUDINAL CONFIGURATION 139
LATERAL CONFIGURATION 4

This one has a lot of pitch authority. This one is not much different from the last one (longitudinal configuration 138). Maybe a little more pitch authority early. The damping seems to be about the same. Kind of the same technique as the last configuration. I don't think I can do it very aggressively. I may have to sneak up on this one. The pitch rate is just a little too high for the damping. What I'm having to do is use partial back stick to hold the final pitch rate down. And then there is the manner of relaxing the back pressure to stop it. It stops real quickly when you just relax the back pressure. There is a tendency to overshoot. So you have to let the target get well within the 80 mil circle before you stop it. If you don't use full back stick on this one, it is a very simple matter of stopping it because it's so dead beat. When you relax the back pressure it just stops basically right where you want it.

STEM 7 TEST 7
PILOT F
LONGITUDINAL CONFIGURATION 139
LATERAL CONFIGURATION 2

A lot more sensitivity in pitch. Acceleration rate is about what it was before and then the capture is a problem because of the pitch sensitivities. I'm going to have to back off the stick input, because it gets accelerating way too fast and if I go full deflection stick, I'm going to have to counter it with a full unload very shortly thereafter. Otherwise, the nose is going to overshoot. It's sort of like the nose is on this big bunge cord--if I yank it, it takes off and then I've got to stop it well before it gets there or I've got an overshoot coming. It's real sensitive in pitch. The acceleration is very high. The maximum actual pitch rate seems higher. In order to stop it once the rate builds up, I'm having to do some pretty aggressive and early stick unloads to release the back pressure.

STEM 7 TEST 7
PILOT G
LONGITUDINAL CONFIGURATION 139
LATERAL CONFIGURATION 4
CHR 4
PIO -

I tend to over control longitudinally when I'm trying to track it. I'm using large pitch displacements. I'm over correcting it. It seems like I'm making the large displacements, but they are obviously bigger than they need to be. A matter of difficulty timing when to come off the back pressure, when to bring the back pressure back in. I can't track it quite as fine. It seems like it takes large stick movements. I am hitting the back stop again during the tracking occasionally. I don't need as much lead as I had been using, so that's pretty good. It is controllable. Is adequate performance obtainable with tolerable pilot work load? Yes. Satisfactory without improvement? I don't believe so. I think desired performance is obtainable. It's a good quick response, it gets there quickly, and I think towards the end I figured out I did not need as much lead. So the lead was not as much compensation as was the large stick movements to stop it and then to keep it up there. It seems like I'm almost running out of elevator authority once I hit the point because I am hitting the aft stick. So I think it had minor but annoying deficiencies.

STEM 7 TEST 7
PILOT A
LONGITUDINAL CONFIGURATION 176
LATERAL CONFIGURATION 2
CHR 4
PIO 2

The technique that works the fastest is to slap the stick to the full aft stop and then immediately release the stick on a smooth back off to neutral so that the nose rate stops on the target. If I attempt to sustain full aft stick any longer I overshoot the target and it gets driven out of parameters. So in order to get the pitch response I want I'm forced to drive the system with a full aft stick input and then very carefully shape my fazing out of that stick input to keep from going beyond the target. So

it's not really a pleasant way to do it, it's requiring quite a bit of pilot compensation. But I'm getting there nice and quick. The time it takes is very fast. If I do a slightly more mission representative stick input which is not all the way to the aft stop, then the fazing out feels a little more natural. And that's what I'm going to do this time. It is going to just take slightly longer. But that's the way people would do it I think. The initial pitch acceleration is pretty good but the capture takes quite a bit of anticipation. You have to smoothly release the stick, otherwise you drive past and get into a pitch PIO. Is was always controllable and always adequate performance was attainable with a tolerable workload. Is it satisfactory without improvement or do deficiencies warrant improvement? Desired performance requires moderate pilot compensation with an annoying deficiency. That's a pretty reasonable description. In order to get the rate I want, I'm using full aft stick or near full aft stick. But then the rate I get is good and desired. But I'm having to do a lot of compensation for the end game. If, with that big stick input, I attempt to put an abrupt forward input to stop my rate, I have trouble predicting what the nose position is going to be. I have to start thinking about stick shaping as soon as I get the onset of my initial pitch rate. I have to be smooth with the forward stick. If I don't give a smooth forward stick with lots of anticipation time, then I miss my desired criteria. So it's requiring moderate compensation and it's a annoying deficiency. PIO rating. There was a tendency here and I can prevent or eliminate them but if I put in an abrupt maneuver and the maneuver I'm talking about is to check my pitch rate to stop on the target, then it tends to bobble outside of the desired criteria. I get at least two overshoots. So in order to get rid of those I have to use pilot technique.

STEM 7 TEST 7
PILOT E
LONGITUDINAL CONFIGURATION 176
LATERAL CONFIGURATION 2

That one is controllable with some pilot compensation. I can use full back stick on this one initially and then just let up on it a little early and be ready to compensate. It's fairly lightly damped at the top. Seems to be a little easier to control in the pitch capture task than the last configuration. The pitch performance is probably not quite as good so I can use full back stick initially and still be able to capture the target with a little compensation. So this one has got pretty good combination of parameters I'd say. Probably the best combination that I've seen so far. Still quite a bit of compensation required if you're going to use an aggressive technique.

STEM 7 TEST 7
PILOT F
LONGITUDINAL CONFIGURATION 176
LATERAL CONFIGURATION 2

On that one, I had a pitch overshoot beyond the target because the onset rate was higher. I felt like I put the stick control in faster and when I went to recapture, I got a little bit of lateral bobble to acquire the target. Obviously a pilot technique there caused a little difference at the top of that. Same pilot, different banana. I was a little fast starting that maneuver, let me get closer to the 122 knots. I just barely touched the back stop about a third of the way through the maneuver--came

off and then captured with a slight bobble, not nearly as bad as when I bagan the maneuver at 130 knots entry speed. It seems that the pitch control gets more solid at the slower start conditions. Again I hit full deflection I think about a third the way through maneuver and I bobbled at the end. I unloaded a little too quickly in pitch once I got the capture and it dropped me down below the target. I don't have to stay full deflection for any length of time. As a matter of fact, I'm just barely touching the back stop before coming off of it on that configuration. It seems to me at that airspeed, it's a reasonable pitch control and pitch authority. I've seen about 80 to 85 knots when I get the capture. The only comment I would have on that configuration is that it's a little bit sensitive down below 95 in pitch as far as stabilizing on the target. It's well within something a pilot could adapt to, but I noticed once I got capture, if I came off the pitch too rapidly, I'd bobble. If I came off slowly, it tended to stay onto the target.

STEM 7 TEST 7
PILOT G
LONGITUDINAL CONFIGURATION 176
LATERAL CONFIGURATION 2
CHR 3
PIO -

It's a little bobbley. A mild tendency to overshoot on this. It's not delaying the task too much though. It's kind of a timing thing. The tracking capability seems pretty good. It's not real easy but it's not real difficult either. I'm just using a full aft stick and then relaxing the full aft stick prior to the target reaching the reticle. It seems like fairly good pitch response. I did notice previously that I would overshoot so I'm having to use a little compensation to not pull through the target. It's very controllable. Adequate performance is attainable with a tolerable workload. Satisfactory without improvement? I'd say yes. There's minimal pilot compensation required. The only compensation required is a little earlier lead in coming off the back pressure than is natural. The tracking capability is pretty good. Pitch capabilities pretty good. You just have to lead coming off the back pressure to avoid the overshoot.

STEM 7 TEST 7
PILOT A
LONGITUDINAL CONFIGURATION 177
LATERAL CONFIGURATION 2
CHR 2
PIO 1

This is very nice, quick and predictable. The nose stops where I want with a quick enough response that I know when it's going to happen so I can leave the aft stick in to get the better rate for a longer period. I'm getting comfortable enough with it that I'm really getting almost full control throw out of the aircraft and still hitting my desired criteria. It's nice and quick, precise. I didn't go to full stop on the controls that time because the rate is good enough that I don't feel any necessity to demand more out of the airplane, its given me what I want. That's a very nice, precise, quick position change of the nose there to a very predictable end game. This requires a little bit of compensation to make sure that I'm getting to the final end game that I want. Quite a nice

harmony between the rate and the end game handling characteristics. That one involved a checkback, a check forward to stop the rate and then a reapplication of the aft stick to hold the nose position. But nice and predictable. That's a natural thing to do with the stick to make a change like that, and generally I can hold the target well inside of the desired criteria error bars. So I like this configuration, it's nice and fast. Controllable? Yes. Adequate? Yes. Satisfactory without improvement? Yes. Every time I hit desired criteria and the maximum I ever saw was one overshoot. The time to get there was good. I didn't feel the need to pull to full aft stick and wait for a long time. I could just get to full aft stick then check forward and then apply this reapplication to hold my nose there. So that had very negligible problems. Not a tendency to PIO. The nose would just kind of clamp in and sit on the target even when I was overdriving it. And very little pilot compensation. So even though it's not the best CHR 2 I've ever seen I don't think it's as bad as a 3. And PIO rating - really no tendency.

STEM 7 TEST 7
PILOT E
LONGITUDINAL CONFIGURATION 177
LATERAL CONFIGURATION 2

This one is going to be more lightly damped obviously. I am not going to be able to be quite as aggressive on this. This one I can't use all the pitch performance that the airplane has for this short of a pitch task - 20 degrees, or whatever it is. I'm having to let up on it so that I can capture it quicker at the other end. And even so it's a matter of timing to try to get it stopped just the right time. Quite a bit of pilot compensation in the tracking task. Fairly lightly damped. I'm probably using about half the pitch performance that it has available to allow me to stop it more predictably.

STEM 7 TEST 7
PILOT F
LONGITUDINAL CONFIGURATION 177
LATERAL CONFIGURATION 2

On that particular one, real aggressive pitch and a pitch overshoot with it. Entry parameters were basically 30 pitch and 122 knots, I went almost full deflection immediately and had a pitch overshoot over top, so I would say that the pitch rate is adequate and the acceleration is adequate to the point where I couldn't stop it. Topped with a capture unload that wasn't soon enough. Okay on that one, I would suspect your data is going to show that there's a little bit slower pitch input and the capture is more controlled at the top. It was definitely less time to capture on that one. If I go full aft stick deflection with this configuration, I am having trouble stopping at the top as far as controlling and capturing. If I back off on the pitch onset rate, which is well within the capability of this flight control system, I don't have any trouble with the pitch capture at the top. If I have a smooth and aggressive pitch entry, I can control the capture. If I go with reckless abandon in the pitch, I'm having trouble with the capture at the top due to pitch capture and control.

STEM 7 TEST 7
PILOT G
LONGITUDINAL CONFIGURATION 177
LATERAL CONFIGURATION 2
CHR 4
PIO -

That's pretty quick. This seems to have a quick response but it doesn't require as much lead. It seems a little harder to prevent the overshoots. It seems like I'm having a little more trouble initially stabilizing it within the pipper. Once the air speed bleeds off I can track pretty well but right after the initial pull it's difficult to track. As long as I'm trying to come out the loop a little bit and not make as many inputs to the stick I can hold it. It seems a little sensitive to the pitch control. I am just trying to get it in there and freeze the stick rather than aggressively track it. It's good and stable as long as you don't get it the loop there and try to aggressively track the target. It's real easy to get into a PIO type situation. You need to get it in there and kind of freeze the stick. I feel like if the reticle was any smaller I'd have a lot more difficulty. As you probably see from my inputs I'm trying to pull it up, get it within the pipper then just come off the back pressure a little bit and freeze the stick. I'm conscientiously trying to keep from aggressively tracking the target which seems to lead to a PIO situation. It is controllable. Is adequate performance attainable with tolerable pilot workload? Yes. I don't believe it's satisfactory without improvement. It's not extensive compensation. It is more like considerable pilot compensation. You could meet desired performance. There is a moderate pilot compensation required in that you cannot get aggressively into the loop to track the target or you'll end up with a mild PIO.

STEM 7 TEST 7
PILOT A
LONGITUDINAL CONFIGURATION 178
LATERAL CONFIGURATION 2
CHR 4
PIO 1

It's just about impossible to PIO this one because of the sluggish nose response. I'm putting in full aft stick. I can almost hold full aft stick right up until I'm inside the error bars and then release the stick and the nose just kind of stops. It's a very heavy nosed airplane and everything is good, it's very predictable. The problems are that it just takes too long. My desires for an aircraft are that I shouldn't have to put in a full control input and then wait long enough to curse the airplane before I get to what I want. The airplane should immediately be giving me what I want, especially under these circumstances where I'm only making a twenty degree pitch change and yet I find myself with this configuration sitting there with a full aft stick in long enough that I have time to think of improvements to it. The overall time is not bad. It's not taking long enough that I'm worried about anything except target capture, but it's still too long for ideal handling qualities. Controllable? Yes. Adequate? Always within adequate criteria. As far as overshoots go, never more than an overshoot. The problem here is deciding whether that's an adequate amount of time or desirable amount of time. My definition of a inadequate amount of time would be where I started to be worried about safety or where I thought the target had time to do something and come back

at me. We aren't at that stage. Adequate amount of time is where I can get my nose up there and I can get a missile off before he can do anything but I'd start thinking of other alternative ways of getting my nose up or using the system to get a lock and shoot a missile or something. Desired is where I put in the aft stick and the nose comes up and that's obviously the way that I'd want to move the airplane to get that solution. This configuration is at the threshold between adequate and desired. I have to put in full stick or very near full stick, pause a couple seconds, and then I got my nose on him. I'm going to call it on the low threshold of desired, so I'm going to say adequate is attainable. And is it satisfactory without improvement or does it warrant improvement? It feels kind of doggy bringing the nose up. I would prefer quicker nose response. And PIO, I don't think you could PIO this airplane. There's just not enough short period response out of the aircraft to get yourself into that gain situation.

STEM 7 TEST 7
PILOT E
LONGITUDINAL CONFIGURATION 178
LATERAL CONFIGURATION 2

This one is pretty poor pitch performance. Much lower pitch rate than the previous configuration (longitudinal configuration 179) but easier to control on the capture. I can use full back stick without any problem. It will stop very easily, very controllable in the capture. Pitch performance is kind of poor. Tracking performance is real good.

STEM 7 TEST 7
PILOT F
LONGITUDINAL CONFIGURATION 178
LATERAL CONFIGURATION 2

You have a very stable, sluggish pitch control entry. It's very stable at 122 knots 30 degrees pitch--no problem. I can tell right now is going to have to be full deflection to get the onset rate even close to what the previous configuration (longitudinal configuration 177). Capture is not a problem. I was backing off a little too early, so I think for this configuration you're going to need full aft stick deflection held a little bit longer and a slower release rate so that you can get the capture complete. If you back off too early, the pipper is not going to come around on target. Okay, on that one, I adjusted for the sluggishness in pitch by coming to a full aft stick, and holding it much longer. I'd say probably twice the length of the previous run on this configuratio. and the other configurations as well. I held it a lot longer and released it a lot later and the pitch rate stopped almost immediately when I released it, so the capture qualities and stability qualities are very good. The agility qualities are not so good. This pitch rate in my opinion would be unsatisfactory tactically compared to the other one (longitudinal configuration 177), I'd prefer to have that pitch rate. I have a feeling I'm capturing faster with this configuration than I did the other one, and I'm complaining about it. This one is definitely more controllable. The stick forces are higher and the onset rate is slower, but as far as controlling a capture situation and the controllability requirements related to capture, this is probably a better configuration for this one specific task. I don't like the heavy stick forces involved getting the

pitch onset rate. Well now that I've bad mouthed this configuration all this much, I'm getting the target quicker and stabilizing faster.

STEM 7 TEST 7
PILOT G
LONGITUDINAL CONFIGURATION 178
LATERAL CONFIGURATION 2
CHR 5
PIO -

Very slow response. It's going to be easy to track but there's not much there as far as initial response of the aircraft. Sluggish. I just pull, wait and freeze. You can stop it on a dime so it's got excellent tracking capability. But it's a very slow response. Everything is happening in slow motion here. It is controllable. Adequate performance is attainable. I don't think it's satisfactory without improvement because of the time required. It has a sluggish pitch capability. It's smooth, it's easy to track but the thing that's driving my rating here is getting there in desired time versus adequate time. So this is one of those areas where I think I'm being a little more performance driven than I am flying qualities driven. It's a good tracker. It doesn't require a lot of compensation. It's a pretty open loop task to pull the nose up to the target but it's so slow that I find it objectionable. I don't believe I can get there in a desired time. It requires adequate time so adequate performance is what I achieve.

STEM 7 TEST 7
PILOT A
LONGITUDINAL CONFIGURATION 179
LATERAL CONFIGURATION 2
CHR 2
PIO 2

This configuration has a very nice balance between stick requirements, rate and end game. I'm basically slapping in the full aft stick and with a very natural forward release the nose stops deadbeat right on the target. The technique that works fastest in this is full aft or nearly full aft stick, and then approaching the target a natural release, and as I get to the target then load up the stick very slightly aft again to hold the new pitch attitude. And it stops dead virtually right on the target every time. The response looks so quick to me though that I suspected we might have a PIO problem so I tried some bang-bang captures full aft and full forward to stop and then I got into a three to four peak oscillation that occasionally was getting outside desired criteria. My judgement is that's kind of an unrealistic input. The response is so nice out of this and quick and crisp that I don't think pilots would be driving at full aft and full forward to try and get it to stop. They would have enough response so that wouldn't happen. But there is a tendency to PIO and if you got into a high gain task such as a maneuvering target trying to get to a very quick gunshot the PIO might come out. So that's my only drawback. Controllable? Yes. Adequate? Yes. Satisfactory without improvement? Yes. I really don't think the pilots are going to be having to compensate for that PIO at least not within the constraints of this particular handling task. So I'm going to say compensation is really not a factor. It is out there but you have to do something unnatural with the stick to make it happen. So I think that deficiency is basically negligible. This is a nice handling, well

balanced configuration for this task. But under PIO, undesirable motions occur when I initiate abrupt maneuvers and I attempt tight control on the end game capture. But these can be prevented or eliminated by pilot technique.

STEM 7 TEST 7
PILOT E
LONGITUDINAL CONFIGURATION 179
LATERAL CONFIGURATION 2

This has pretty good pitch performance. Not great and tracking is not too difficult. I have to lead it a little bit. Not too much. If I use full back stick it's a little difficult to capture. I would have to practice with it a little bit. It wants to stop pretty quickly when you relax back stick.

STEM 7 TEST 7
PILOT F
LONGITUDINAL CONFIGURATION 179
LATERAL CONFIGURATION 2

This one is a little goosey. But I like this one. Let me tell you why. It's got a real nice onset rate and it's got a very nice capture. It seems like it has the nice pitch response you want for maneuver initiation, I'm getting a very nice rate prior to full deflection which gives me some range to control the rate and I'm backing off and I'm getting a nice stable capture. I'm not having such a tremendous rate build-up that I can't control it at the end when I come backing off despite it is a high rate when I'm backing off. I'm stopping the rate and then it captures nicely. Very nice. I like this one. A nice brisk onset and nice ability control the pitch decel by releasing control or backing off of the pitch. I'm not having to deal with the bobble and overshoot at the top.

STEM 7 TEST 7
PILOT G
LONGITUDINAL CONFIGURATION 179
LATERAL CONFIGURATION 2
CHR 3
PIO -

It's quick. Actually this seems pretty good. It has a good, quick response but I'm not required to lead it by much. I can pretty much wait until it gets in the reticle. It seems to have pretty good stopping capability. Just pull it up and put it in there. It is controllable. Is adequate performance attainable with tolerable pilot workload? Yes. Is it satisfactory without improvement? I'll say yes. I think there's some fair, some mildly unpleasant deficiencies. There's minor pilot compensation going on during the tracking. I just don't feel very consistent. I can reach desirable performance. Sometime I can nail it but sometimes there's some bobbling going on there. There's never a danger of more than one overshoot at all though. I am having a hard time describing what my compensation is once it reaches the reticle. But I can kind of sense my workload going up a little bit there. I don't feel it's negligible. This was more responsive than the last (longitudinal configuration 178). It may have been a second's difference or fractions of

a second but the initial response, the feel of the stick during the pull has a lot to do with the pilot's opinion to where you feel like you're really waiting on the airplane. You are more concerned with stopping your rate on the target on what we would consider a good configuration versus the last configuration. On the last one, you just pull and now you're waiting and pilots don't like to wait on the airplane.

## Summary of Design Parameters Tested for STEM 7 TEST 8

Test variables:

WSP: Indicates a variation in $\omega_{sp}$ since this is a low speed flight condition. $\omega_{sp}$ scheduled linearly with knots equivalent airspeed (KEAS) with the following value at 100 KEAS:

(-) 0.5 rad/sec, Level 2 for high AOA acquisition from MCAIR research

(+) 1.67 rad/sec, Solid Level 1 value for high AOA acquisition from MCAIR research

(++) 2.5 rad/sec, Level 2 value for high AOA acquisition from MCAIR research

ZSP: Short period damping:

(-) 0.6, Level 2

(+) 1.0, Level 1

(++) 1.4, Level 1

KQ: Indicates longitudinal stick sensitivity. This also affects maximum q:

(-) 6.0°/sec/in, Acceptable level of sensitivity.

(+) 8.0°/sec/in,

### Test Matrix

| Lon Config | Lat Config | WSP | ZSP | KQ | PLT |
|---|---|---|---|---|---|
| 752 | 11 | 1.67 (1) | 1.0 (1) | 6.0 (0) | 7 |
| 757 | 11 | 2.5 (2) | 1.0 (1) | 6.0 (0) | 7 |
| 756 | 11 | 0.5 (0) | 1.0 (1) | 6.0 (0) | 7 |
| 751 | 11 | 1.67 (1) | 0.6 (0) | 6.0 (0) | 7 |
| 753 | 11 | 1.67 (1) | 1.4 (2) | 6.0 (0) | 7 |
| 799 | 11 | 1.67 (1) | 1.4 (2) | 8.0 (1) | 7 |

STEM 7 TEST 8
PILOT G
LONGITUDINAL CONFIGURATION 751
LATERAL CONFIGURATION 11
CHR 6
PIO 3

This is quick. Definitely a tendency to PIO. I'm using a very small input. It seems like it stops pretty well from a slow rate. I'm really having to back off on the control input to keep it from running away from me though. Once again, it's just like there's that acceleration phenomena. I set a stick position. The rate looks nice and smooth and zoom it takes off. A little more difficult to track with this configuration. This does not respond the way I want it to. Once you get in the circle and pretty much just leave the stick alone, then you're okay and track real well. You definitely don't want to overshoot because it's a bear trying to get it back. I really need to keep my control inputs small, very small. If you use a big input one direction, you're going to use a big input in the other direction. So you really have to use a small input and just live with the delay. I'm guessing I'm using less than a one-third stick travel which makes the nose not move as fast as I want it to initially but any more than that and I can't handle the overshoot. We're definitely dealing with the adequate performance criteria here. Is it controllable? Yes. Is adequate performance attainable with a tolerable pilot workload? It's probably tolerable. It's definitely not satisfactory. I have to kind of quantify my pilot compensation in terms of considerable or extensive. That's a tough one. It could almost fall either place in terms of considerable or extensive. I'm going to rate it as extensive. It is very objectionable because I'm not allowed to make the control inputs that I want to make. It doesn't fly predictably. I want to be able to make a big input and be able to control that input and I can't. I have to artificially reduce my control inputs due to the configuration. I have to be very careful, both in the starting and the stopping of the maneuver. These motions can be prevented or eliminated but only at sacrifice to task performance or through considerable pilot attention and effort.

STEM 7 TEST 8
PILOT G
LONGITUDINAL CONFIGURATION 752
LATERAL CONFIGURATION 11
CHR 4

It is real easy to overshoot this thing. It's almost like there's a pitch acceleration that occurs. If you are looking at the target I'll come aft stick and everything looks good and then it almost takes off if I don't come off of the stick. So it seems like there's either going to be big overshoots or I'll be stair stepping my way up to the target. A lot of judgment is involved here. It's like there's a hugh pitch acceleration about 30° of pitch. It's an eye-watering pitch with a large overshoot. I've got two different techniques; one is I can go aft stick for about a second and then it will go full forward to try to catch it. That gets me close and then it's real easy to track. But I think a better technique is going to be to use probably about half stick with less rate. And I think I'm going to end up acquiring it quicker. It will cut down on that overshoot. I mean I still get a good rate but I can only command as much rate as I can handle to prevent the overshoot. So I'm using probably a half, maybe three-quarter stick. If I use full it's just too much. It

looks like I'm hitting the forward stop every now and then as I try to stop the rate but it's a rate that I can handle. So I might have a small tendency to undershoot versus overshoot on this technique but I feel more comfortable. I think I can get stabilized on the target just a fraction of a second quicker. We're probably only talking about a one second difference in the two techniques. Tracking is very, very simple in this configuration. I like the tracking characteristics but the gross acquisition is difficult. I have to live with a slower acquisition rate initially but now I've got a rate I can control when I try to stop it. It is controllable. Adequate performance is easily obtained. Is it satisfactory without improvement? No. Does adequate performance requires extensive pilot compensation? Not really. Typically, adequate is not that difficult because at worst you're usually talking about one overshoot which is still within desired but it does require moderate pilot compensation. It's just too quick and its not a stable either. It just doesn't seem like a stable pitch rate. It's not very predictable. It will really take off on you as time continues on the pull. But overall a very nice configuration to track with.

STEM 7 TEST 8
PILOT G
LONGITUDINAL CONFIGURATION 753
LATERAL CONFIGURATION 11
CHR 4

This one isn't too bad. A little tendency to overshoot. I'm able to use full stick displacements. It's a very comfortable rate. One overshoot but easy to control. I've got a nice quick response in terms of trying to reverse the direction of the input. It does seem a little sloppy, it likes to coast in the direction it's going. But I don't quite see as much of the acceleration phenomena we were talking about earlier. It's very nice to track with. I wouldn't say it stops on a dime but it stops. It seems like I get similar results whether I decide to use a low input or a large input. Obviously the size of my input affects the size of my capture input but a full input seems controllable and manageable. So this is probably going to be one of the few that I'm able to use a full stick input on. And it's predictable enough to where I can go full forward stick and stop it. It is controllable. Adequate performance is easily obtained. Is it satisfactory without improvement? Desired performance is pretty easy. I'd say there is a need to get the timing right for when to reverse the thing. This is one of those areas where I feel like that performance criteria is starting to fall into play where there's not that much pilot compensation required; however, I think, overall, the performance is a little slow as far as the pitch response. I'd thing I'd like a little bit faster pitch response. So in terms of the scale, I'd say minimal pilot compensation is required for a desired tracking performance in terms of overshoots; however, the desired performance does not fall within a desired time. I consider it slow. So it's kind of like a compromise between the two. So I'll say requires moderate pilot compensation but it's really not the pilot compensation that has downgraded it from the next level. It's the slow response that has downgraded it.

STEM 7 TEST 8
PILOT G
LONGITUDINAL CONFIGURATION 756
LATERAL CONFIGURATION 11
CHR 6

If I come full aft, it's a nice, comfortable rate but then when I try to stop it I run out of control power. It's a real delay. Very slow rates. Very delayed as far as trying to stop it. I go full forward stick and get a huge overshoot, then full aft stick. You have to really, really lead your inputs, like there's an enormous inertia going on here or something. And especially if I get an overshoot I'm probably going to get a second overshoot if not a third. That's using full stick deflections. This is a terrible tracker too. It's because of this huge delay. It looks like a pretty comfortable rate but then you get the big overshoot. Is it controllable? Yes. Is adequate performance attainable with a tolerable pilot workload? Yes. Adequate performance requires extensive pilot compensation? You just have to use horrendous lead points to even obtain the adequate performance. It's a totally unnatural airplane to fly. It's very objectionable. It may be a little bit better in tracking but it's a very poor tracking airplane as well.

STEM 7 TEST 8
PILOT G
LONGITUDINAL CONFIGURATION 757
LATERAL CONFIGURATION 11
CHR 5

This one might be a little quicker than the other one (Longitudinal configuration 752). I find the tracking on this pretty nice. This is very quick, very, very quick. I've even been trying to use less stick than I did before and it really accelerates. It almost seems like there is an acceleration, whether it's real or an illusion. It's not a constant pitch rate. That one looked fairly constant with this low input. But there's the illusion of a pitch acceleration command almost if I use a constant stick setting. As soon as I see the rate start to take off, that's when I come forward with the stick to try to arrest the rate. It is controllable. Adequate performance is attainable with a tolerable workload. It is definitely not satisfactory. I can typically hit desired but I think it requires considerable pilot compensation. If you try to go for a natural, full input, you're going to overshoot several times. I was able to achieve desired performance; however, I could also say it's not within a desired time in terms of the performance. I have to really cut back on my input to try to get my nose up there. But once again the tracking is very good.

STEM 7 TEST 8
PILOT G
LONGITUDINAL CONFIGURATION 799
LATERAL CONFIGURATION 11
CHR 3

I can use full stick when I come off and I can just stop it right there. It still seems a little sluggish in response to stopping it. It is controllable. Adequate performance is attainable with a tolerable pilot workload. It is satisfactory without improvement. It's still kind of borderline but it's not too bad. The response is okay, just a little bit

sluggish but not too bad. The compensation mainly comes in where you're going to make your lead point, and it's a fairly predictable lead point that you use. So I would say it's minimal pilot compensation required for desired performance. It is a fair, mildly unpleasant deficiency, the deficiency being the sluggishness in stopping the acquisition and maybe a little bit slow in the pitch response, but mainly it's trying to stop the pitch rate. It was a little sluggish.

## Summary of Design Parameters Tested for STEM 7 TEST 9

Test variables:

CAP:

(-) 0.08

(+) 0.28

ZSP: Maintained constant at 0.8.

### Test Matrix

| Lon Config | Lat Config | CAP | ZSP |
|---|---|---|---|
| 504* | 402 | 0.08 (-) | 0.8 |
| 504 | 402 | 0.28 (+) | 0.8 |

STEM 7 TEST 9 (Transport Aircraft Testing)
PILOT I
LONGITUDINAL CONFIGURATION 504
LATERAL CONFIGURATION 402

There's a little PIO on the acquisition there. Obviously you wouldn't be moving the nose of a heavy in a power approach configuration this drastically. And to tell you the truth, I don't think the amount of pitch change is going to matter if you do it at a operationally significant rate. I'm slow enough that you just basically just stop where you want it. Now if you increase the rate then you get some overshoots out of it. I guess the other idea of the task would be to drive the small circle up to the point you were looking to get. So that I'm not putting any lead compensation in. Now I do get into a couple of overshoots. And the difference being that I'm not taking out any control input until I get to the line and then trying to stop it on the line basically. Otherwise, when I compensate and try to make the capture I just can do it pretty easily and nothing comes out of t.

STEM 7 TEST 9 (Transport Aircraft Testing)
PILOT I
LONGITUDINAL CONFIGURATION 504* (CAP=0.08)
LATERAL CONFIGURATION 402

This is a much more sluggish response and pretty good overshoots there. I don't know how drastic of a change you made but I can see a pretty considerable change in the pitch characteristics of the airplane right here. I am probably looking at a minimum of two overshoots there. Slow pitch response. Too slow. But I did see quite a bit of difference from the first one.

## Data Contents for STEM 8: Crossing Target Acquidsition and Tracking

Maneuver tested at Vmin with AOA command systems

- Summary of Design Parameter Variations Tested
- Pilot Comments

## Summary of Design Parameters Tested for STEM 8

Test variables:

CAP: Indicates a variation in $\omega_{sp}$ since this is a low speed flight condition. $\omega_{sp}$ scheduled linearly with knots equivalent airspeed (KEAS) with the following value at 100 KEAS:

(-) 0.754 rad/sec, Level 1/2 boundary for high AOA acquisition from MCAIR research

(+) 1.067 rad/sec, Solid Level 1 value for high AOA acquisition from MCAIR research

PMAX: Variations in maximum attainable stability axis roll rate.

(-) slow, a schedule with AOA was implemented based on MIL-STD-1797A and MCAIR high AOA research.

| AOA | PMAX |
|---|---|
| 5° | 150.0 deg/sec |
| 15° | 100.0 deg/sec |
| 30° | 90.0 deg/sec |
| 60° | 60.0 deg/sec |

(+) fast, a schedule with AOA was implemented based on MIL-STD-1797A and MCAIR high AOA research.

| AOA | PMAX |
|---|---|
| 5° | 180.0 deg/sec |
| 15° | 150.0 deg/sec |
| 30° | 90.0 deg/sec |
| 60° | 60.0 deg/sec |

TR: Variations in roll mode time constant.

(-) sluggish, a schedule with AOA was implemented based on MIL-STD-1797A and MCAIR high AOA research.

| AOA | TR |
|---|---|
| 5° | 0.6 sec |
| 15° | 1.0 sec |
| 30° | 1.8 sec |
| 60° | 2.1 sec |

(+) quick, a schedule with AOA was implemented based on MIL-STD-1797A and MCAIR high AOA research.

| AOA | TR |
|---|---|
| 5° | 0.4 sec |
| 15° | 0.6 sec |
| 30° | 1.0 sec |
| 60° | 1.6 sec |

**Test Matrix**

| Lon Config | Lat Config | CAP (WSP) | PMAX | TR |
|---|---|---|---|---|
| 305 | 205 | 0.3 (-) | Fast (+) | Quick (+) |
| 304 | 205 | 0.6 (+) | Fast (+) | Quick (+) |
| 305 | 206 | 0.3 (-) | Slow (-) | Quick (+) |
| 305 | 207 | 0.3 (-) | Fast (+) | Sluggish (-) |
| 304 | 208 | 0.6 (+) | Slow (-) | Sluggish (-) |

STEM 8
PILOT G
LONGITUDINAL CONFIGURATION 305
LATERAL CONFIGURATION 205
CHR 4

That one didn't seem that bad although I had some difficulty tracking. Once again I don't need full lateral stick. I got a tracking solution that time but it seemed like I had to start out leading the target quite a bit. I'm getting a lot of lateral PIOs here. I think the 2 second criteria is working out pretty good on this because in 1 second the guy could probably just fly through your reticle and you won't get anything out of it. If you have a better acquisition airplane where you get there quicker now the tracking is more of a 2 axis tracking. If you're late getting to the airplane, then you're almost wings level and it becomes a pure lateral task. On this one, I'm having some difficulty when it's a pitch and roll but once it gets pure roll I'm doing a little bit better. I'm not sure exactly what I'm doing with this configuration but I'm definitely having more difficulty keeping a solution. I think an interesting piece of data is when the pilot comes off of full back stick and starts to try to lead his tracking solution. It seems like the lateral is a little bit too touchy for me or something. I can't quite get the response that I want. I'll tend to overcorrect laterally during the tracking. If I were to back off of the aft stick a little bit, then I wouldn't get the acquisition as quick but the tracking would be better. And I think that's true of all the configurations. There's some optimal point to stop the acquisition and transition to the tracking. On the previous configuration I could pull right to the target almost and release and stop it on him. This one is probably somewhere in between that and previous configurations where I had to lead it by quite a bit it. It is definitely controllable. Adequate performance is attainable with a tolerable pilot workload. I don't like this configuration quite as much. I don't feel it's satisfactory without improvement. I'm more in the desired performance requires moderate pilot compensation. The pilot compensation comes in terms of the tracking more than anything else. I find the lateral axis a little more difficult to handle. A lot more bobbling. It's more difficult to match the line of sight rate than other configurations have been.

STEM 8
PILOT H
LONGITUDINAL CONFIGURATION 305
LATERAL CONFIGURATION 205
CHR 4

The acquisition is no problem. Is it controllable? Yes it is controllable. Is adequate performance obtainable? Yes. Is it satisfactory without improvement? No. I got desired performance after 2 to 3 times and the last time I just missed it so I'd say I got desired performance. It requires moderate pilot compensation. The acquisition was no problem. When I went to reverse and tried to keep him tracking, it was difficult for me to keep him within that circle. I'm fighting the lateral stick there trying to keep it on the target. The pitch didn't seem to be a problem. The roll might have been a little sensitive.

STEM 8
PILOT G
LONGITUDINAL CONFIGURATION 304
LATERAL CONFIGURATION 205
CHR 4

This one seems very similar to the previous one (Longitudinal configuration 305, lateral configuration 206). Just maybe a little more bobbly on my first attempt. It does not require full lateral stick for initial acquisition. Your nose ends up too low. This is similar to the previous one as far as you can really stop your pitch on a dime during the initial acquisition but then it seems a little bit more difficult trying to coordinate the pitch and roll to keep the track right on him. That run I tried not to lead as much and it was really quick, so I might be closing in on a optimal technique here. So now I'm just pulling to get the pipper on the target and then when it gets there, I am unloading to track. Now I'm getting lots of bobbles though. It seems like there's a little bit of a snowball effect on this maneuver as far as you've either got it nailed or you don't. If you're lucky enough to nail it you're golden. It seems like I'm able to acquire easier and get a better acquisition although the tracking is a little more difficult. Although, like I said, I'm not matching his line of sight nearly as well as other configurations. It seems like the key to this configuration is getting your pipper right in plane with him at the initial outset and then it's rather easy to track. But if you end up a little high or a little low, it's difficult to make the corrections. With this configuration I feel much more comfortable tracking when I'm in more of the pitch tracking task than I am the lateral tracking task. Is it controllable? Yes, it is controllable. Is adequate performance attainable with tolerable pilot workload? Yes, it is. Is it satisfactory without improvement? I don't think so. I can typically get desired performance. Desired performance requires moderate compensation. I believe that to be the case. I find the deficiencies in this airplane primarily lateral. I like the good pitch response and I can quickly get an acquisition and release a little back pressure and stop the nose right on the guy and it's a better pitch tracker than a lateral tracker.

STEM 8
PILOT H
LONGITUDINAL CONFIGURATION 304
LATERAL CONFIGURATION 205
CHR 4

The roll seems a little more stable but I'm flopping around in pitch. Almost as if it is too sensitive in pitch. I don't seem to be fighting the lateral stick. It seems to be that I get it there, then I'm drifting off with the pitch. That run felt real good. I think I got the pitch thing squared away earlier so I didn't have to mess with the pitch once I got there. But on the other runs, when I started to roll, I didn't have him in the circle. I had to fight both of them at the same time. It was making it more difficult. So I got lined up longitudinally better this time. Is it controllable? Yes. Is adequate performance attainable? Yes. Is it satisfactory without improvement? No. I didn't really have to compensate laterally. I felt that was much better than last time (Longitudinal configuration 305, lateral configuration 205). Once I got the pitch solution or the vertical displacement figured out and I had the circle on him, the roll control was much smoother. It was easier to control, it wasn't flopping around as much on the lateral axis. If I had to make a

correction using pitch then I would keep overshooting. Almost a PIO but not really. And then I'd be out of alpha there before I got to the end. I like this one better than the last time in roll. But maybe it just highlighted the pitch problems. I wasn't having to compensate hardly at all laterally but I was definitely compensating a lot more in pitch.

STEM 8
PILOT G
LONGITUDINAL CONFIGURATION 305
LATERAL CONFIGURATION 206
CHR 4

This seems pretty easy. I ended up a little bit of lag. It seems slower to get to the target and I'm not having to try to lead it as much. I don't have a whole lot of pitch left by the time I get to the target. Though I'm wandering around a little bit here. This one I do feel like I don't have to lead by as much but I'm also not tracking quite as successfully. I definitely stay in aft stick longer. It seems like the first one (Longitudinal configuration 304, lateral configuration 208) is the only one I was able to use full lateral stick on. I'm not able to use full lateral on this one either. I don't consider it to be overly sensitive but it seems like that's my biggest problem during the tracking solution. It does seem like I can stop my pitch a lot quicker which means I can continue my pull a little bit longer during the acquisition phase. I think my major problems are pitch during the tracking. I feel like I can delay my lead a little bit more on the acquisition. Most of my difficulty tracking is in pitch but it's also not quite as smooth laterally as the previous one (Longitudinal configuration 305, lateral configuration 207). I think this one is a little bit touchier laterally. It's a little more difficult. I don't know if it's more responsive or what but it's more difficult to match the line of sight rate than the previous one and there's some more pitch bobbles than the previous one. But I would consider the pitch to be very responsive in terms of being able to stop nose rate. Yes, it is controllable. Adequate performance is attainable with a tolerable pilot workload. I don't think it's satisfactory without improvement. Adequate performance did not require extensive pilot compensation. It wasn't that hard. In fact, I typically got desired performance. However, the desired performance does require moderate pilot compensation. I think there's a lot more pitch bobbling going on and it's more difficult to match the line of sight rate with your roll. I did find it desirable to have the quick pitch capability to stop my initial acquisition but I think I got more pitch bobbles during the tracking as I tried to set up the tracking so therefore I feel it was desired performance with moderate pilot compensation.

STEM 8
PILOT H
LONGITUDINAL CONFIGURATION 305
LATERAL CONFIGURATION 206
CHR 5

That one didn't really nail him initially. It felt kind of slower in roll. When I went to reverse it, it seemed like it wasn't going as fast as the other configurations. Also on the initial pull up, I've noticed it seemed to be rolling slower. I am not able to get my nose over there as quick as it was before. Is it controllable? Yes. Is adequate performance

obtained? Yes. Is it satisfactory without improvement? No. I only got desired performance this last time and the time previously but to me I think that was not the norm. I didn't like this one. The roll was not responsive enough. It felt too sluggish. Once the target really started tracking across I was always lagging behind so I don't think I was getting the roll performance I needed to do a nice tracking task. I'm going to go with adequate performance. It does require considerable pilot compensation and the objectionable deficiencies are the roll. Just seems too sluggish and I can't keep up with the target.

STEM 8
PILOT G
LONGITUDINAL CONFIGURATION 305
LATERAL CONFIGURATION 207
CHR 3

That was different. My nose seemed to significantly drop there. And there's my track. That was interesting. The initial move seemed significantly different than the first one configuration (Longitudinal configuration 305, lateral configuration 207). The tracking didn't turn out to be that much different. Maybe a little bit better. Seemed like I found it easier to track. Looks like I'm having a more difficult time getting in plane with him initially to start the track but the tracking itself is easier. I'm having to fly the acquire a little bit differently. If I just park the stick in the aft left the nose really drops below the horizon in the end. So maybe it has a quicker roll or I'm getting to higher alpha and it's rolling below the horizon. So I'm not using near as much lateral stick for the acquisition. But once I get the pipper close it seems like it's easier for me to match his line of sight on this one. I find it much easier to track once I'm near wings level. Then it becomes more lateral versus a longitudinal tracking task. The longitudinal tracking task seems more difficult. Once I become wings level it becomes more lateral. It definitely seems I have much more difficulty controlling my longitudinal axis than before but I can control my lateral axis better. I'm still playing with the aggressiveness of the pull to the target. I still have a natural tendency to unload as I try to lead the target. I don't know if it really has much to do with the airplane characteristics. I am finding that I'm going to get a lot of pilot variability here in terms of when I begin my lead point to start tracking him. So I'll continue to fly it like I flew the last one which was I'm going to use whatever I think I need to start the track.

STEM 8
PILOT G
LONGITUDINAL CONFIGURATION 305
LATERAL CONFIGURATION 207
CHR 3

That was different. My nose seemed to significantly drop there. And there's my track. That was interesting. The initial move seemed significantly different than the first configuration (Longitudinal configuration 304, lateral configuration 208). The tracking didn't turn out to be that much different. Maybe a little bit better. Seemed like I found it easier to track. Looks like I'm having a more difficult time getting in plane with him initially to start the track but the tracking itself is easier. I'm having to fly the acquire a little bit differently.

If I just park the stick in the aft left the nose really drops below the horizon in the end. So maybe it has a quicker roll or I'm getting to higher alpha and it's rolling below the horizon. So I'm not using near as much lateral stick for the acquisition. But once I get the pipper close it seems like it's easier for me to match his line of sight on this one. I find it much easier to track once I'm near wings level. Then it becomes more lateral versus a longitudinal tracking task. The longitudinal tracking task seems more difficult. Once I become wings level it becomes more lateral. It definitely seems I have much more difficulty controlling my longitudinal axis than before but I can control my lateral axis better. I'm still playing with the aggressiveness of the pull to the target. I still have a natural tendency to unload as I try to lead the target. I don't know if it really has much to do with the airplane characteristics. I am finding that I'm going to get a lot of pilot variability here in terms of when I begin my lead point to start tracking him. So I'll continue to fly it like I flew the last one which was I'm going to use whatever I think I need to start the track. Instead of flying the pipper to the target, I am letting the target fly to the pipper. And that allows me to start working on my tracking solution a lot sooner. It's very easy to match his rate throughout the maneuver. Any time I'm pulling towards him then I'm increasing the line of sight rate obviously because my nose is going his way. If I just quickly get my nose near his and now stop my nose line of sight that's going to reduce the overall line of sight rate so now I've got a smoother tracking solution. Once he approaches about 20 degrees field of view that's when I stop my nose rate and now I'm just smoothly starting to track him very nicely. Very, very easy to track. This is a much easier set of dynamics to track the airplane. I'm not sure exactly why but I'm finding it much smoother. A little bit of pitch bobbling though but the lateral characteristics are really superb for this task. Is it controllable? Yes. Is adequate performance attainable with a tolerable pilot workload? Yes. Is it satisfactory without improvement? Yes. There's definitely compensation required here. Probably the biggest pilot compensation was the need to relax the back pressure as the target approaches the pipper initially so you can begin your tracking solution. If you decide not to do that, if you just bring your pipper to him, and then try to track, it's going to be a much more difficult task. But I was very happy with the tracking performance.

STEM 8
PILOT H
LONGITUDINAL CONFIGURATION 305
LATERAL CONFIGURATION 207
CHR 5

It's almost as though the nose is wandering around a little bit. Kind of just scribing little circles around there. That time I was tracking him and I'm rolling and I don't think I'm moving the stick a whole lot and then all of a sudden the roll just took off on me, or something changed. Is it controllable? Yes. Is adequate performance obtained? Yes. Is it satisfactory without improvement? No. I think in the four data runs, I got two desired performance. I was definitely was compensating a lot. The control seemed kind of sloppy. I thought I was tracking the target and all of a sudden the airplane just started taking off in roll more than I'd thought I'd put in. I don't know what the deal was there. And I would call that a moderately objectionable deficiency. Even though I did get desired performance I didn't like the fact that I was getting that bobble and I wasn't able to control it so I'm going to mark that one. It has

moderate deficiencies, adequate performance requires considerable compensation. Those two times I got desired I think I was pretty much lucky.

STEM 8
PILOT G
LONGITUDINAL CONFIGURATION 304
LATERAL CONFIGURATION 208
CHR 4

I just pull, and roll over, and try to get in plane to where he flies into my pipper, and now I'm trying to just roll, have a smooth roll tracking him and there I got the flashers. Let me try again. I'm back in the aft left, getting in plane with the target. Now I start unloading and start trying to get a smooth roll to match his line of sight. I'm leading him a little bit too much. I'm not finding too much difficulty in control harmony as far as the pitch and the roll. Neither one seems to be overly sensitive. I feel like the control harmony is good. There is a tendency to lead it a little bit early which is contaminating my capture time. The key is trying to match a roll rate with his line of sight rate. Is it controllable? Yes, it is controllable. Is adequate performance attainable with a tolerable pilot workload? I would say yes, it is. Is it satisfactory without improvement? No. I don't think that pilot compensation is extensive. We're sitting somewhere between adequate performance requires considerable compensation, and desired performance requires moderate. I got desired performance twice, I got adequate twice. The key is trying to match your roll rate with the target. I don't think it's much a matter of adequate performance requiring considerable pilot compensation. There's not that much compensation involved here. You just have to find the right rate and once you do that, the desired performance is not that difficult to achieve. So I'd say that desired performance requires moderate pilot compensation. There is a tendency to back off the back pressure as you approach the target which is going to reduce the time before you first get the target inside of the pipper. But that's a natural tendency to try to lead it a little bit so that you start getting your tracking solution earlier. I feel like if I pull all the way and don't start reversing my roll until I can get him inside the pipper, then I'm going to be playing catch up during the tracking.

STEM 8
PILOT H
LONGITUDINAL CONFIGURATION 304
LATERAL CONFIGURATION 208
CHR 6

Initially it didn't roll where I wanted it to roll. Real slow build up in roll. I started to roll and nothing was happening and then it seems to catch up and then I get this pitch problem. It's definitely sensitive in pitch and real laggy in initial roll response. Is it controllable? Yes. Is adequate performance attainable? I think I got it a couple times. It is definitely not desired performance - not a chance at that. There is extensive compensation because of the slow roll response build up. You put a little stick in and it doesn't do anything and then you put the stick in further. Then it catches up and you have gone too far. While you are doing that, the pitch is going crazy. It is definitely sensitive in pitch. It was tough to control.

## Data Contents for STEM 9: Pitch Rate Reserve

TEST 1: Maneuver tested at V≈180 knots, AOA≈38°, AOA Command systems

- Summary of Design Parameter Variations Tested
- Numerical Summary of Statistical Analysis
- Bar Graphs of Measures of Merit
- Design Parameter Correlations, Pilot Variability, and Overall Correlations
- Pilot Comments

TEST 2: Maneuver tested at V≈180 knots, AOA≈38°, AOA Command systems different matrix than TEST 1

- Summary of Design Parameter Variations Tested
- Numerical Summary of Statistical Analysis
- Bar Graphs of Measures of Merit
- Design Parameter Correlations, Pilot Variability, and Overall Correlations
- Pilot Comments

## Design Parameters Tested for STEM 9 TEST 1

Test variables:

CAP: Indicates a variation in $\omega_{sp}$ since this is a low speed flight condition. $\omega_{sp}$ scheduled linearly with knots equivalent airspeed (KEAS) with the following value at 100 KEAS:

(-) 0.729 rad/sec, Level 1/2 boundary for high AOA acquisition from MCAIR research

(+) 1.067 rad/sec, Solid Level 1 value for high AOA acquisition from MCAIR research

ZSP: A schedule of ZSP was implemented based on AOA:

For low AOA (≤10°), ZSP maintained at:

(-) 0.35, Level 1/2 boundary from MIL-STD-1797A

(+) 0.70, Within the Level 1 region from MIL-STD-1797A and generally good for acquisition

For high AOA (30°), ZSP maintained at:

(-) 0.6, Level 1/2 boundary for high AOA maneuvering from MCAIR research

(+) 1.2, Solid Level 1 value for high AOA maneuvering from MCAIR research

LONSHP: Indicates whether or not non-linear stick shaping is being used:

(-) No shaping, longitudinal dynamics do not vary with stick position

(+) Shaping, $\omega_{sp}$ reduced and $\zeta_{sp}$ increased for for small incremental stick inputs

### Test Matrix

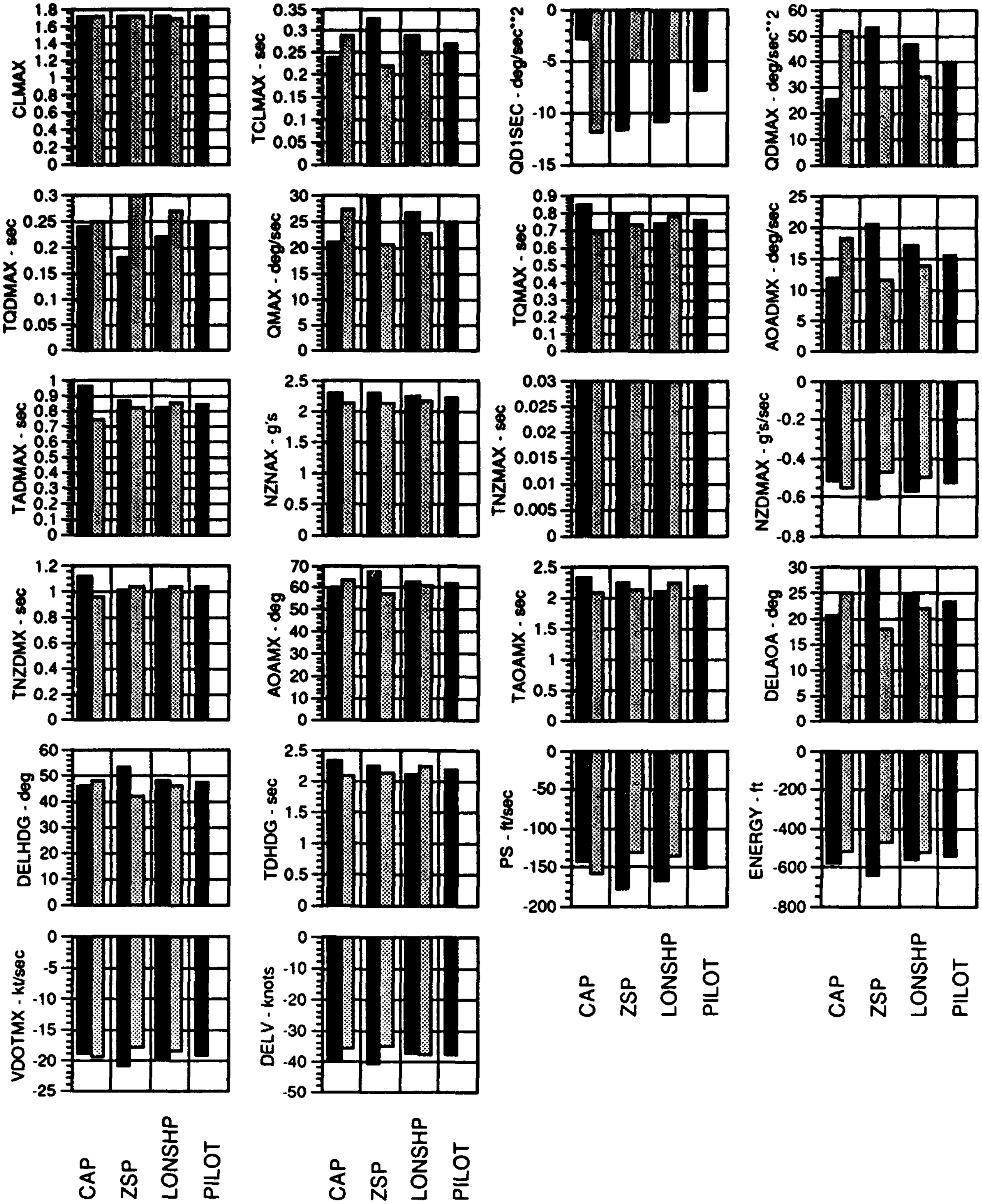
| Lon Config | Lat Config | CAP | ZSP | LONSHP |
|---|---|---|---|---|
| 108 | 11 | 0.28 (-) | 0.35/0.6 (-) | On (+) |
| 153 | 11 | 0.60 (+) | 0.35/0.6 (-) | Off (-) |
| 152 | 11 | 0.28 (-) | 0.70/1.2 (+) | Off (-) |
| 110 | 11 | 0.60 (+) | 0.70/1.2 (+) | On (+) |

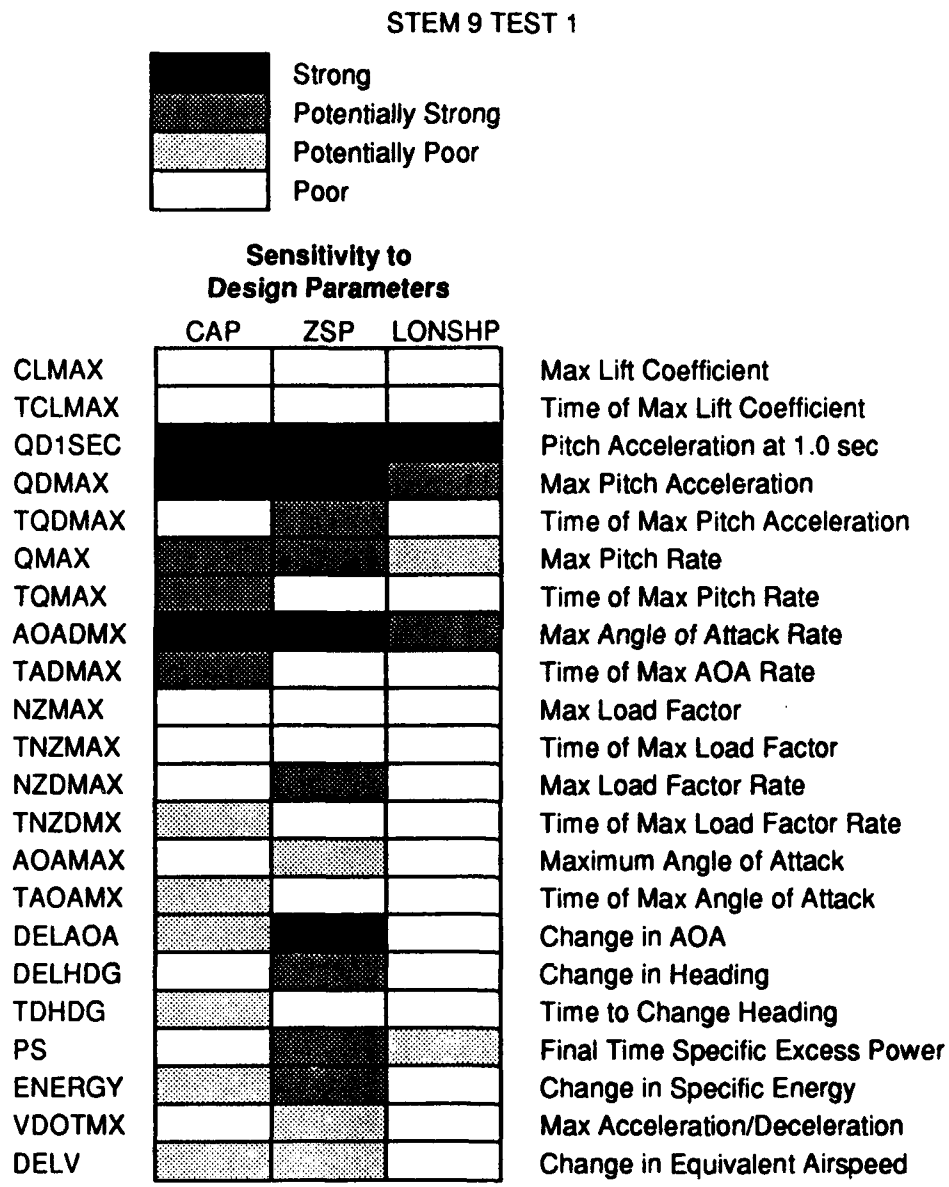
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | CLMAX | 0.4046 | CAP | 0.537 | 1.7176 | 1.7066 | 0 | 0 | -0.006 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.553 | 1.7177 | 1.7065 | 0 | 0 | -0.007 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.603 | 1.719 | 1.[illegible]038 | 0 | 0 | -0.009 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 1.7114 | | 0 | 0 | 0.000 | | | | |
| 3 | TCLMAX | 0.4343 | CAP | 0.457 | 0.2366 | 0.2939 | 0 | 0 | 0.219 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.767 | 0.3339 | 0.2181 | 0 | 0 | -0.439 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.298 | 0.29 | 0.2476 | 0 | 0 | -0.159 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 0.2688 | | 0 | 0 | 0.000 | | | | |
| ### | QD1SEC | 0.9999 | CAP | 1.000 | -2.9033 | -11.874 | 0 | 0 | -1.923 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.999 | -11.66 | -5.0637 | 0 | 0 | 0.934 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.999 | -10.85 | -5.0488 | 0 | 0 | 0.842 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | -7.9495 | | 0 | 0 | 0.000 | | | | |
| 6 | QDMAX | 0.9999 | CAP | 1.000 | 24.935 | 51.689 | 0 | 0 | 0.795 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | ZSP | 1.000 | 53.297 | 29.63 | 0 | 0 | -0.621 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.991 | 46.291 | 33.677 | 0 | 0 | -0.324 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 39.984 | | 0 | 0 | 0.000 | | | | |
| 7 | TQDMAX | 0.526 | CAP | 0.195 | 0.2366 | 0.255 | 0 | 0 | 0.075 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.850 | 0.1839 | 0.2959 | 0 | 0 | 0.494 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.366 | 0.2212 | 0.2726 | 0 | 0 | 0.210 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 0.2469 | | 0 | 0 | 0.000 | | | | |
| 8 | QMAX | 0.9999 | CAP | 1.000 | 20.985 | 27.115 | 0 | 0 | 0.259 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | ZSP | 1.000 | 29.608 | 20.408 | 0 | 0 | -0.381 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.998 | 26.416 | 22.45 | 0 | 0 | -0.163 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 24.433 | | 0 | 0 | 0.000 | | | | |
| 9 | TQMAX | 0.8822 | CAP | 0.963 | 0.8508 | 0.6883 | 0 | 0 | -0.214 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.589 | 0.7911 | 0.7348 | 0 | 0 | -0.074 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.657 | 0.74 | 0.7788 | 0 | 0 | 0.051 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 0.7594 | | 0 | 0 | 0.000 | | | | |
| 11 | AOADMX | 0.9999 | CAP | 1.000 | 11.871 | 18.288 | 0 | 0 | 0.446 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | ZSP | 1.000 | 20.417 | 11.642 | 0 | 0 | -0.592 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 1.000 | 17.248 | 13.713 | 0 | 0 | -0.231 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 15.481 | | 0 | 0 | 0.000 | | | | |
| 12 | TADMAX | 0.9674 | CAP | 0.993 | 0.958 | 0.7439 | 0 | 0 | -0.256 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.520 | 0.8625 | 0.8181 | 0 | 0 | -0.053 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.674 | 0.8212 | 0.8538 | 0 | 0 | 0.039 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 0.8375 | | 0 | 0 | 0.000 | | | | |
| 14 | NZMAX | 0.9125 | CAP | 0.913 | 2.293 | 2.1322 | 0 | 0 | -0.073 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.940 | 2.3017 | 2.1254 | 0 | 0 | -0.080 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.514 | 2.2542 | 2.1509 | 0 | 0 | -0.047 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 2.2025 | | 0 | 0 | 0.000 | | | | |
| 15 | TNZMAX | 0.0167 | CAP | 0.191 | 0.0294 | 0.0272 | 0 | 0 | -0.079 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.210 | 0.0268 | 0.0292 | 0 | 0 | 0.089 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.117 | 0.0275 | 0.0288 | 0 | 0 | 0.048 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 0.0282 | | 0 | 0 | 0.000 | | | | |
| 16 | NZDMAX | 0.9958 | CAP | 0.643 | -0.5167 | -0.5478 | 0 | 0 | -0.059 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.999 | -0.6137 | -0.4724 | 0 | 0 | 0.265 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.890 | -0.5686 | -0.4999 | 0 | 0 | 0.129 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | -0.5342 | | 0 | 0 | 0.000 | | | | |
| 17 | TNZDMX | 0.7137 | CAP | 0.923 | 1.1151 | 0.955 | 0 | 0 | -0.156 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.298 | 1.0053 | 1.0404 | 0 | 0 | 0.034 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.440 | 1.0087 | 1.0413 | 0 | 0 | 0.032 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 1.025 | | 0 | 0 | 0.000 | | | | |
| 20 | AOAMX | 0.9999 | CAP | 1.000 | 59.975 | 63.492 | 0 | 0 | 0.057 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | ZSP | 1.000 | 67.536 | 57.611 | 0 | 0 | -0.160 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.404 | 62.538 | 61.369 | 0 | 0 | -0.019 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 61.954 | | 0 | 0 | 0.000 | | | | |

STEM 9 TEST 1

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 21 | TAOAMX | 0.8191 | CAP | 0.902 | 2.308 | 2.0772 | 0 | 0 | -0.106 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.503 | 2.2268 | 2.1404 | 0 | 0 | -0.040 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.821 | 2.1087 | 2.2476 | 0 | 0 | 0.064 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 2.1782 | | 0 | 0 | 0.000 | | | | |
| 23 | DELAOA | 0.9999 | CAP | 0.996 | 20.68 | 24.935 | 0 | 0 | 0.188 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | ZSP | 1.000 | 29.615 | 17.986 | 0 | 0 | -0.520 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.715 | 24.199 | 21.948 | 0 | 0 | -0.098 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 23.074 | | 0 | 0 | 0.000 | | | | |
| 28 | DELHDG | 0.9944 | CAP | 0.529 | 45.813 | 47.716 | 0 | 0 | 0.041 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.999 | 53.398 | 41.816 | 0 | 0 | -0.247 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.124 | 47.697 | 46.07 | 0 | 0 | -0.035 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 46.883 | | 0 | 0 | 0.000 | | | | |
| ### | TDHDG | 0.8191 | CAP | 0.902 | 2.308 | 2.0772 | 0 | 0 | -0.106 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.503 | 2.2268 | 2.1404 | 0 | 0 | -0.040 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.821 | 2.1087 | 2.2476 | 0 | 0 | 0.064 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 2.1782 | | 0 | 0 | 0.000 | | | | |
| 36 | PS | 0.9228 | CAP | 0.511 | -144.1 | -157.77 | 0 | 0 | -0.091 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.969 | -178.26 | -131.2 | 0 | 0 | 0.311 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.843 | -167.99 | -135.59 | 0 | 0 | 0.216 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | -151.79 | | 0 | 0 | 0.000 | | | | |
| 37 | ENERGY | 0.9994 | CAP | 0.938 | -580.81 | -518.09 | 0 | 0 | 0.115 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | ZSP | 1.000 | -641.86 | -470.61 | 0 | 0 | 0.315 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.001 | -560.36 | -530.7 | 0 | 0 | 0.054 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | -545.53 | | 0 | 0 | 0.000 | | | | |
| 38 | VDOTMX | 0.9848 | CAP | 0.456 | -18.938 | -19.462 | 0 | 0 | -0.027 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.996 | -20.918 | -17.922 | 0 | 0 | 0.155 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.873 | -20.061 | -18.405 | 0 | 0 | 0.086 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | -19.233 | | 0 | 0 | 0.000 | | | | |
| 39 | DELV | 0.9843 | CAP | 0.972 | -40.41 | -35.692 | 0 | 0 | 0.124 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | ZSP | 0.988 | -40.828 | -35.367 | 0 | 0 | 0.144 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | LONSHP | 0.569 | -37.654 | -37.858 | 0 | 0 | -0.005 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | -37.756 | | 0 | 0 | 0.000 | | | | |

STEM 9 TEST 1


CLMAX
TCLMAX - sec
QD1SEC - deg/sec**2
QDMAX - deg/sec**2
TQDMAX - sec
QMAX - deg/sec
TQMAX - sec
AOADMX - deg/sec
TADMAX - sec
NZNAX - g's
TNZMAX - sec
NZDMAX - g's/sec
TNZDMX - sec
AOAMX - deg
TAOAMX - sec
DELAOA - deg
DELHDG - deg
TDHDG - sec
PS - ft/sec
ENERGY - ft
VDOTMX - kt/sec
DELV - knots
CAP
ZSP
LONSHP
PILOT




Note: Data available for only a single pilot, therefore, sensitivity to pilot variability and overall sensitivity not shown.

STEM 9 TEST 1
PILOT D
LONGITUDINAL CONFIGURATION 108
LATERAL CONFIGURATION 11

It seemed like the pitch duration was not that long, but the speed of the pitch was pretty good. On that one, the residual pitch authority was real nice. It got the nose going at a much faster rate than was the established turn. It seemed to go through about a 45 degree arc before the authority just kind of died out. There are undeniably other little roll out impulses put in there, but the initial pitch reserve is of a short enough duration that it is pretty much purely longitudinal there for a second or so.

STEM 9 TEST 1
PILOT D
LONGITUDINAL CONFIGURATION 153
LATERAL CONFIGURATION 11

This one it seems like we get our alpha a little bit faster while setting up than the other ones. That one appears to be very little residual pitch authority. It just only goes about 20 degrees and then stops.

STEM 9 TEST 1
PILOT D
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 11

All set. There we go, pulling. There's the rate slowing right about there--stop maneuver. You know, the funny thing is that as the angle of bank rolls out of the airplane, it appears to provide more angular movement of the pipper across the horizon. It is really hard to tell when the rate slows down and stops, because it looks like even at 69, I'm getting some residual pitch. This one appears to have much less pitch authority available

STEM 9 TEST 1
PILOT D
LONGITUDINAL CONFIGURATION 110
LATERAL CONFIGURATION 11

No comments.

## Design Parameters Tested for STEM 9 TEST 2

Test variables:

CAP: Indicates a variation in $\omega_{sp}$ since this is a low speed flight condition. $\omega_{sp}$ scheduled linearly with knots equivalent airspeed (KEAS) with the following value at 100 KEAS:

(-) 0.729 rad/sec, Level 1/2 boundary for high AOA acquisition from MCAIR research

(+) 1.067 rad/sec, Solid Level 1 value for high AOA acquisition from MCAIR research

ZSP: A schedule of ZSP was implemented based on AOA:

For low AOA (≤10°), ZSP maintained at:

(-) 0.35, Level 1/2 boundary from MIL-STD-1797A

(+) 0.70, Within the Level 1 region from MIL-STD-1797A and generally good for acquisition

For high AOA (30°), ZSP maintained at:

(-) 0.6, Level 1/2 boundary for high AOA maneuvering from MCAIR research

(+) 1.2, Solid Level 1 value for high AOA maneuvering from MCAIR research

LONSNS: Indicates longitudinal stick sensitivity. Zero stick bias on AOA adjusted so that the maximum AOA is 71.5° regardless of the longitudinal stick sensitivity.

(-) 9.0°/in, Acceptable level of sensitivity but potentially borderline high.

(+) 13.0°/in, High sensitivity.

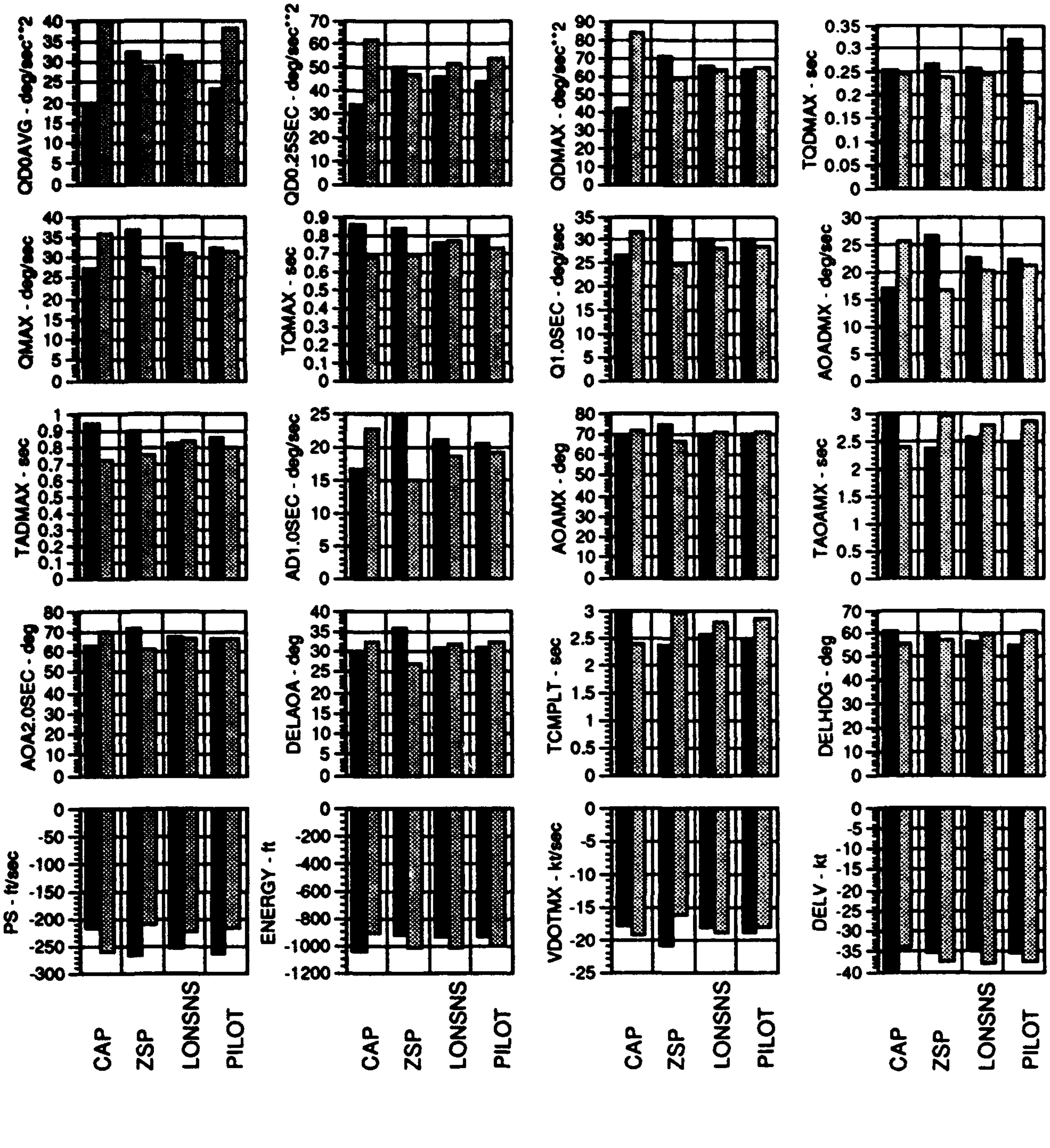
### Test Matrix (Pilots E,G)

| Lon Config | Lat Config | CAP | ZSP | LONSNS |
|---|---|---|---|---|
| 140 | 11 | 0.28 (-) | 0.35/0.6 (-) | 13.0 (+) |
| 141 | 11 | 0.60 (+) | 0.35/0.6 (-) | 9.0 (-) |
| 142 | 11 | 0.28 (-) | 0.70/1.2 (+) | 9.0 (-) |
| 143 | 11 | 0.60 (+) | 0.70/1.2 (+) | 13.0 (+) |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4 | QD0AVG | 0.9886 | CAP | 0.998 | 19.979 | 39.691 | 0 | 0 | 0.742 | 1.50 | 1 | 2 | 2 |
| | (0.25 sec) | | ZSP | 0.264 | 32.402 | 28.91 | 0 | 0 | -0.114 | 0.23 | 4 | 3 | 4 |
| | | | LONSNS | 0.266 | 31.521 | 29.635 | 0 | 0 | -0.062 | 0.12 | 4 | 3 | 4 |
| | | | PLT | 0.992 | 23.471 | 37.842 | 0 | 0 | 0.496 | | | | |
| 5 | QDXSEC | 0.9777 | CAP | 0.999 | 33.548 | 61.821 | 0 | 0 | 0.650 | 3.02 | 1 | 1 | 1 |
| | (0.25 sec) | | ZSP | 0.035 | 50.195 | 47.53 | 0 | 0 | -0.055 | 0.25 | 4 | 3 | 4 |
| | | | LONSNS | 0.592 | 46.11 | 52.115 | 0 | 0 | 0.123 | 0.57 | 4 | 3 | 4 |
| | | | PLT | 0.909 | 43.668 | 54.057 | 0 | 0 | 0.215 | | | | |
| 6 | QDMAX | 0.9999 | CAP | 1.000 | 41.447 | 83.839 | 0 | 0 | 0.764 | 47.89 | 1 | 1 | 1 |
| | | | ZSP | 1.000 | 70.394 | 58.425 | 0 | 0 | -0.187 | 11.75 | 3 | 1 | 3 |
| | | | LONSNS | 0.686 | 65.439 | 63.193 | 0 | 0 | -0.035 | 2.19 | 4 | 1 | 4 |
| | | | PLT | 0.983 | 63.895 | 64.923 | 0 | 0 | 0.016 | | | | |
| 7 | TQDMAX | 0.9939 | CAP | 0.189 | 0.2555 | 0.2492 | 0 | 0 | -0.025 | 0.04 | 4 | 3 | 4 |
| | | | ZSP | 0.678 | 0.2649 | 0.2392 | 0 | 0 | -0.102 | 0.18 | 4 | 3 | 4 |
| | | | LONSNS | 0.265 | 0.2572 | 0.246 | 0 | 0 | -0.044 | 0.08 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 0.3198 | 0.1844 | 0 | 0 | -0.579 | | | | |
| 8 | QMAX | 0.9999 | CAP | 1.000 | 27.257 | 35.97 | 0 | 0 | 0.281 | 8.73 | 2 | 1 | 2 |
| | | | ZSP | 1.000 | 36.513 | 27.44 | 0 | 0 | -0.290 | 9.00 | 2 | 1 | 2 |
| | | | LONSNS | 0.999 | 32.97 | 30.802 | 0 | 0 | -0.068 | 2.12 | 4 | 1 | 4 |
| | | | PLT | 0.450 | 32.491 | 31.462 | 0 | 0 | -0.032 | | | | |
| 9 | TQMAX | 0.9999 | CAP | 1.000 | 0.86 | 0.6761 | 0 | 0 | -0.243 | 3.06 | 2 | 1 | 2 |
| | | | ZSP | 1.000 | 0.8358 | 0.685 | 0 | 0 | -0.200 | 2.52 | 2 | 1 | 2 |
| | | | LONSNS | 0.672 | 0.7572 | 0.7642 | 0 | 0 | 0.009 | 0.12 | 4 | 3 | 4 |
| | | | PLT | 0.997 | 0.7906 | 0.7302 | 0 | 0 | -0.080 | | | | |
| 10 | QXSEC | 0.9999 | CAP | 1.000 | 26.724 | 31.615 | 0 | 0 | 0.169 | 3.29 | 3 | 1 | 3 |
| | (1.0 sec) | | ZSP | 1.000 | 34.045 | 24.702 | 0 | 0 | -0.326 | 6.35 | 2 | 1 | 2 |
| | | | LONSNS | 0.970 | 30.36 | 28.207 | 0 | 0 | -0.074 | 1.43 | 4 | 2 | 4 |
| | | | PLT | 0.901 | 30.128 | 28.619 | 0 | 0 | -0.051 | | | | |
| 11 | AOADMX | 0.9999 | CAP | 1.000 | 16.791 | 25.613 | 0 | 0 | 0.435 | 9.73 | 1 | 1 | 1 |
| | | | ZSP | 1.000 | 26.522 | 16.617 | 0 | 0 | -0.485 | 10.85 | 1 | 1 | 1 |
| | | | LONSNS | 1.000 | 22.626 | 20.321 | 0 | 0 | -0.108 | 2.41 | 3 | 1 | 3 |
| | | | PLT | 0.383 | 22.051 | 21.088 | 0 | 0 | -0.045 | | | | |
| 12 | TADMAX | 0.9999 | CAP | 1.000 | 0.9418 | 0.7223 | 0 | 0 | -0.269 | 3.66 | 2 | 1 | 2 |
| | | | ZSP | 1.000 | 0.8983 | 0.7475 | 0 | 0 | -0.185 | 2.51 | 3 | 1 | 3 |
| | | | LONSNS | 0.853 | 0.8149 | 0.8324 | 0 | 0 | 0.021 | 0.29 | 4 | 3 | 4 |
| | | | PLT | 0.998 | 0.8531 | 0.7927 | 0 | 0 | -0.073 | | | | |
| 13 | ADXSEC | 0.9999 | CAP | 1.000 | 16.546 | 22.595 | 0 | 0 | 0.317 | 4.70 | 2 | 1 | 2 |
| | (1.0 sec) | | ZSP | 1.000 | 24.856 | 14.79 | 0 | 0 | -0.543 | 8.05 | 1 | 1 | 1 |
| | | | LONSNS | 0.998 | 20.967 | 18.47 | 0 | 0 | -0.127 | 1.89 | 3 | 2 | 4 |
| | | | PLT | 0.875 | 20.49 | 19.155 | 0 | 0 | -0.067 | | | | |
| 20 | AOAMX | 0.9999 | CAP | 1.000 | 69.029 | 71.256 | 0 | 0 | 0.032 | 1.72 | 4 | 2 | 4 |
| | | | ZSP | 1.000 | 74.5 | 65.97 | 0 | 0 | -0.122 | 6.60 | 3 | 1 | 3 |
| | | | LONSNS | 0.999 | 69.972 | 70.546 | 0 | 0 | 0.008 | 0.44 | 4 | 3 | 4 |
| | | | PLT | 0.999 | 69.587 | 70.883 | 0 | 0 | 0.018 | | | | |
| 21 | TAOAMX | 0.9999 | CAP | 1.000 | 2.9873 | 2.3723 | 0 | 0 | -0.233 | 1.67 | 2 | 2 | 3 |
| | | | ZSP | 1.000 | 2.3691 | 2.9392 | 0 | 0 | 0.217 | 1.56 | 2 | 2 | 3 |
| | | | LONSNS | 0.956 | 2.5495 | 2.7779 | 0 | 0 | 0.086 | 0.62 | 4 | 3 | 4 |
| | | | PLT | 0.997 | 2.4698 | 2.8386 | 0 | 0 | 0.140 | | | | |
| 22 | AOAXSEC | 0.9999 | CAP | 1.000 | 63.025 | 69.636 | 0 | 0 | 0.100 | 46.77 | 4 | 1 | 4 |
| | (2.0 sec) | | ZSP | 1.000 | 71.833 | 61.379 | 0 | 0 | -0.158 | 73.92 | 3 | 1 | 3 |
| | | | LONSNS | 0.952 | 67.174 | 65.935 | 0 | 0 | -0.019 | 8.71 | 4 | 1 | 4 |
| | | | PLT | 0.915 | 66.677 | 66.535 | 0 | 0 | -0.002 | | | | |
| 23 | DELAOA | 0.9999 | CAP | 1.000 | 30.247 | 32.496 | 0 | 0 | 0.072 | 1.59 | 4 | 2 | 4 |
| | | | ZSP | 1.000 | 35.92 | 27.011 | 0 | 0 | -0.289 | 6.39 | 2 | 1 | 2 |
| | | | LONSNS | 0.987 | 31.137 | 31.854 | 0 | 0 | 0.023 | 0.50 | 4 | 3 | 4 |
| | | | PLT | 0.987 | 30.754 | 32.177 | 0 | 0 | 0.045 | | | | |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 27 | TCMPLT | 0.9999 | CAP | 1.000 | 2.9873 | 2.3723 | 0 | 0 | -0.233 | 1.67 | 2 | 2 | 3 |
| | | | ZSP | 1.000 | 2.3691 | 2.9392 | 0 | 0 | 0.217 | 1.56 | 2 | 2 | 3 |
| | | | LONSNS | 0.956 | 2.5495 | 2.7779 | 0 | 0 | 0.086 | 0.62 | 4 | 3 | 4 |
| | | | PLT | 0.997 | 2.4698 | 2.8386 | 0 | 0 | 0.140 | | | | |
| 28 | DELHDG | 0.9974 | CAP | 0.989 | 60.768 | 56.079 | 0 | 0 | -0.080 | 0.75 | 4 | 3 | 4 |
| | | | ZSP | 0.842 | 59.24 | 57.217 | 0 | 0 | -0.035 | 0.33 | 4 | 3 | 4 |
| | | | LONSNS | 0.946 | 56.78 | 59.94 | 0 | 0 | 0.054 | 0.51 | 4 | 3 | 4 |
| | | | PLT | 0.996 | 55.129 | 61.327 | 0 | 0 | 0.107 | | | | |
| 36 | PS | 0.9999 | CAP | 1.000 | -217.1 | -260.7 | 0 | 0 | -0.184 | 0.97 | 3 | 3 | 4 |
| | | | ZSP | 1.000 | -268.7 | -212.73 | 0 | 0 | 0.236 | 1.24 | 2 | 2 | 3 |
| | | | LONSNS | 0.978 | -253.84 | -225.21 | 0 | 0 | 0.120 | 0.63 | 3 | 3 | 4 |
| | | | PLT | 0.999 | -263.42 | -218.02 | 0 | 0 | 0.190 | | | | |
| 37 | ENERGY | 0.9998 | CAP | 1.000 | -1045.2 | -909.22 | 0 | 0 | 0.140 | 2.07 | 3 | 1 | 3 |
| | | | ZSP | 0.993 | -924.03 | -1019.1 | 0 | 0 | -0.098 | 1.45 | 4 | 2 | 4 |
| | | | LONSNS | 0.990 | -932.1 | -1018.2 | 0 | 0 | -0.088 | 1.31 | 4 | 2 | 4 |
| | | | PLT | 0.906 | -938.77 | -1004.4 | 0 | 0 | -0.068 | | | | |
| 38 | VDOTMX | 0.9809 | CAP | 0.763 | -17.899 | -19.171 | 0 | 0 | -0.069 | 1.67 | 4 | 2 | 4 |
| | | | ZSP | 1.000 | -20.895 | -16.281 | 0 | 0 | 0.252 | 6.13 | 2 | 1 | 2 |
| | | | LONSNS | 0.716 | -18.237 | -19.003 | 0 | 0 | -0.041 | 1.00 | 4 | 2 | 4 |
| | | | PLT | 0.548 | -18.97 | -18.206 | 0 | 0 | 0.041 | | | | |
| 39 | DELV | 0.9953 | CAP | 0.999 | -39.06 | -33.989 | 0 | 0 | 0.140 | 2.19 | 3 | 1 | 3 |
| | | | ZSP | 0.876 | -35.093 | -37.533 | 0 | 0 | -0.067 | 1.06 | 4 | 2 | 4 |
| | | | LONSNS | 0.966 | -34.932 | -37.945 | 0 | 0 | -0.083 | 1.30 | 4 | 2 | 4 |
| | | | PLT | 0.801 | -35.159 | -37.467 | 0 | 0 | -0.064 | | | | |

STEM 9 TEST 2



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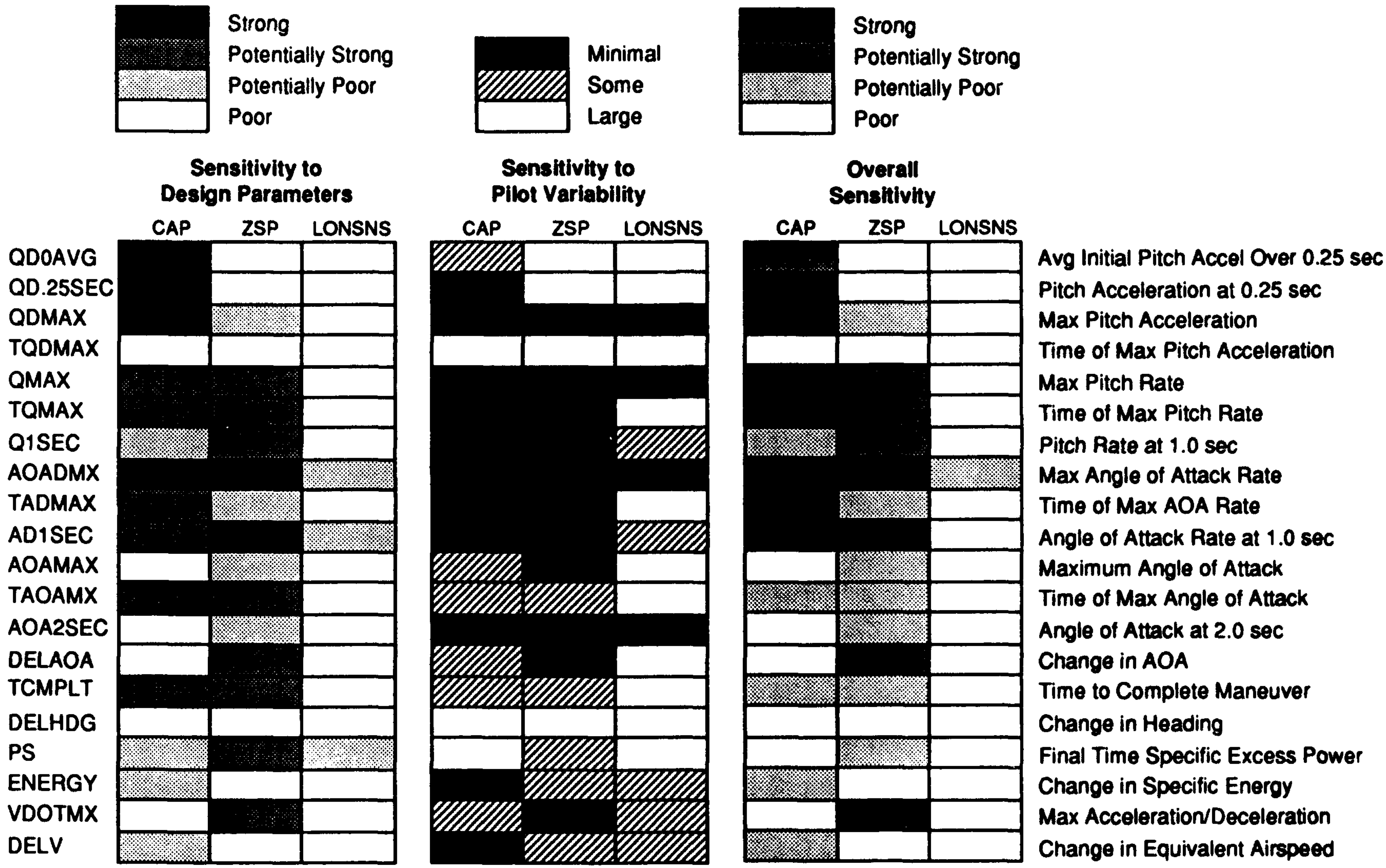
QD0.25SEC - deg/sec**2
QDMAX - deg/sec**2
TQDMAX - sec
QMAX - deg/sec
TQMAX - sec
Q1.0SEC - deg/sec
AOADMX - deg/sec
TADMAX - sec
AD1.0SEC - deg/sec
AOAMX - deg
TAOAMX - sec
AOA2.0SEC - deg
DELAOA - deg
TCMPLT - sec
DELHDG - deg
PS - ft/sec
ENERGY - ft
VDOTMX - kt/sec
DELV - kt
CAP
ZSP
LONSNS
PILOT

STEM 9 TEST 2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Potentially Poor
Poor
Minimal
Some
Large
Strong
Potentially Strong
Potentially Poor
Poor
Sensitivity to Design Parameters
Sensitivity to Pilot Variability
Overall Sensitivity
CAP
ZSP
LONSNS
CAP
ZSP
LONSNS
CAP
ZSP
LONSNS
QD0AVG
QD.25SEC
QDMAX
TQDMAX
QMAX
TQMAX
Q1SEC
AOADMX
TADMAX
AD1SEC
AOAMAX
TAOAMX
AOA2SEC
DELAOA
TCMPLT
DELHDG
PS
ENERGY
VDOTMX
DELV
Avg Initial Pitch Accel Over 0.25 sec
Pitch Acceleration at 0.25 sec
Max Pitch Acceleration
Time of Max Pitch Acceleration
Max Pitch Rate
Time of Max Pitch Rate
Pitch Rate at 1.0 sec
Max Angle of Attack Rate
Time of Max AOA Rate
Angle of Attack Rate at 1.0 sec
Maximum Angle of Attack
Time of Max Angle of Attack
Angle of Attack at 2.0 sec
Change in AOA
Time to Complete Maneuver
Change in Heading
Final Time Specific Excess Power
Change in Specific Energy
Max Acceleration/Deceleration
Change in Equivalent Airspeed

STEM 9 TEST 2
PILOT E
LONGITUDINAL CONFIGURATION 140
LATERAL CONFIGURATION 11

No comments.

STEM 9 TEST 2
PILOT G
LONGITUDINAL CONFIGURATION 140
LATERAL CONFIGURATION 11

I've got a little quicker initial rate and a lot more heading change. It also has a more obvious stopping of the rate versus the other one (longitudinal configuration 143). In that one, I didn't see nearly as much acceleration in the rate and didn't see the deceleration when it reached its max rate and started slowing down. This one is more distinct.

STEM 9 TEST 2
PILOT E
LONGITUDINAL CONFIGURATION 141
LATERAL CONFIGURATION 11

There doesn't seem to be much to compare these things with. Both these configurations (longitudinal configurations 140 and 141) seem to be pretty much the same. It's difficult to tell a difference. The stick forces were a little higher on the other, but that's probably because I've trimmed this configuration. I'll try to note what angle of attack it's getting up to. It was getting up to the 60's or so in the first configuration. About 75 on this one, so it may be getting up to a little higher angle of attack on this configuration. I don't think the speed is bleeding off quite as badly in the turn on this configuration. What I'm doing on this is I'm trimming it down before I start so that it stabilizes about 10 alpha, and then I'm starting it. It makes for little bit higher stick forces, but it seems to work a little better. And like I say I couldn't tell too much difference from one configuration and the other except for the fact that you have to retrim it. Not one to generate a whole lot of good pilot comments probably.

STEM 9 TEST 2
PILOT G
LONGITUDINAL CONFIGURATION 141
LATERAL CONFIGURATION 11

This one looks a lot like the other one (lon config 140). I don't know if it starts any quicker but you can definitely see it stop. This is one where you definitely hit a limit as far your angular reserve. You can definitely see it stopped. Much more defined. This one really lunges. It doesn't appear as if I get quite as much angular reserve as the previous. Probably just as good in initial acceleration if not a little bit better but there's not as much angular reserve left. I don't end up changing the heading as much and there is more distinct end to the tracking. The only other comment on the technique, it is fairly easy to fly and I think having the alpha right up by the airspeed is nice. It allows real quick cross checking. You can see your entry conditions approaching.

STEM 9 TEST 2
PILOT E
LONGITUDINAL CONFIGURATION 142
LATERAL CONFIGURATION 11

That was definitely a different configuration. Angle of attack didn't seem to increase that much on the jerk, and it only got up to 60, 65 maximum. Definitely not as much angular reserve as the first two configurations.

STEM 9 TEST 2
PILOT G
LONGITUDINAL CONFIGURATION 142
LATERAL CONFIGURATION 11

On this one, as you pull, you don't see very much change in the rate at all. There's a very mild increase and then it slowly dissipates but it almost ends up going back to the same rate you had before. So it doesn't look like you have much pitch rate change capability or pitch acceleration capability with this configuration. This configuration is also a little more difficult to hit 38 AOA it seems like. It's not extremely difficult but I'm having a harder time that I was on the previous configurations. There is a mild tendency to go beyond the 38. It's much harder to hold the constant angle of attack during the set up.

STEM 9 TEST 2
PILOT E
LONGITUDINAL CONFIGURATION 143
LATERAL CONFIGURATION 11

No comments.

STEM 9 TEST 2
PILOT G
LONGITUDINAL CONFIGURATION 143
LATERAL CONFIGURATION 11

It's kind of hard to pick up the pitch rate. It's not real obvious in the simulator when you do the stick snatch, you know, as opposed to in an airplane where you can feel everything on the body. There doesn't seem like there's much sensory input that the nose is changing at least on this configuration. The most difficult part is just holding the altitude.

## Data Contents for STEM 10: High AOA Longitudinal Gross Acquisition

AOA command systems tested
Pull to target initiated from AOA≈38°, target AOA for capture was 55° - 60°

- Summary of Design Parameter Variations Tested
- Numerical Summary of Statistical Analysis
- Bar Graphs of Measures of Merit
- Design Parameter Correlations, Pilot Variability, and Overall Corelations
- Pilot Comments

**Summar, of Design Parameter Variations for STEM 10**

Test variables:

CAP: Indicates a variation in $\omega_{sp}$ since this is a low speed flight condition. $\omega_{sp}$ scheduled linearly with knots equivalent airspeed (KEAS) with the following value at 100 KEAS:

(-) 0.729 rad/sec, Level 1/2 boundary for high AOA acquisition from MCAIR research

(+) 1.067 rad/sec, Solid Level 1 value for high AOA acquisition from MCAIR research

ZSP: A schedule of ZSP was implemented based on AOA:

For low AOA (≤10°), ZSP maintained at:

(-) 0.35, Level 1/2 boundary from MIL-STD-1797A

(+) 0.70, Within the Level 1 region from MIL-STD-1797A and generally good for acquisition

For high AOA (30°), ZSP maintained at:

(-) 0.6, Level 1/2 boundary for high AOA maneuvering from MCAIR research

(+) 1.2, Solid Level 1 value for high AOA maneuvering from MCAIR research

LONSHP: Indicates whether or not non-linear stick shaping is being used:

(-) No shaping, longitudinal dynamics do not vary with stick position

(+) Shaping, $\omega_{sp}$ reduced and $\zeta_{sp}$ increased for for small incremental stick inputs

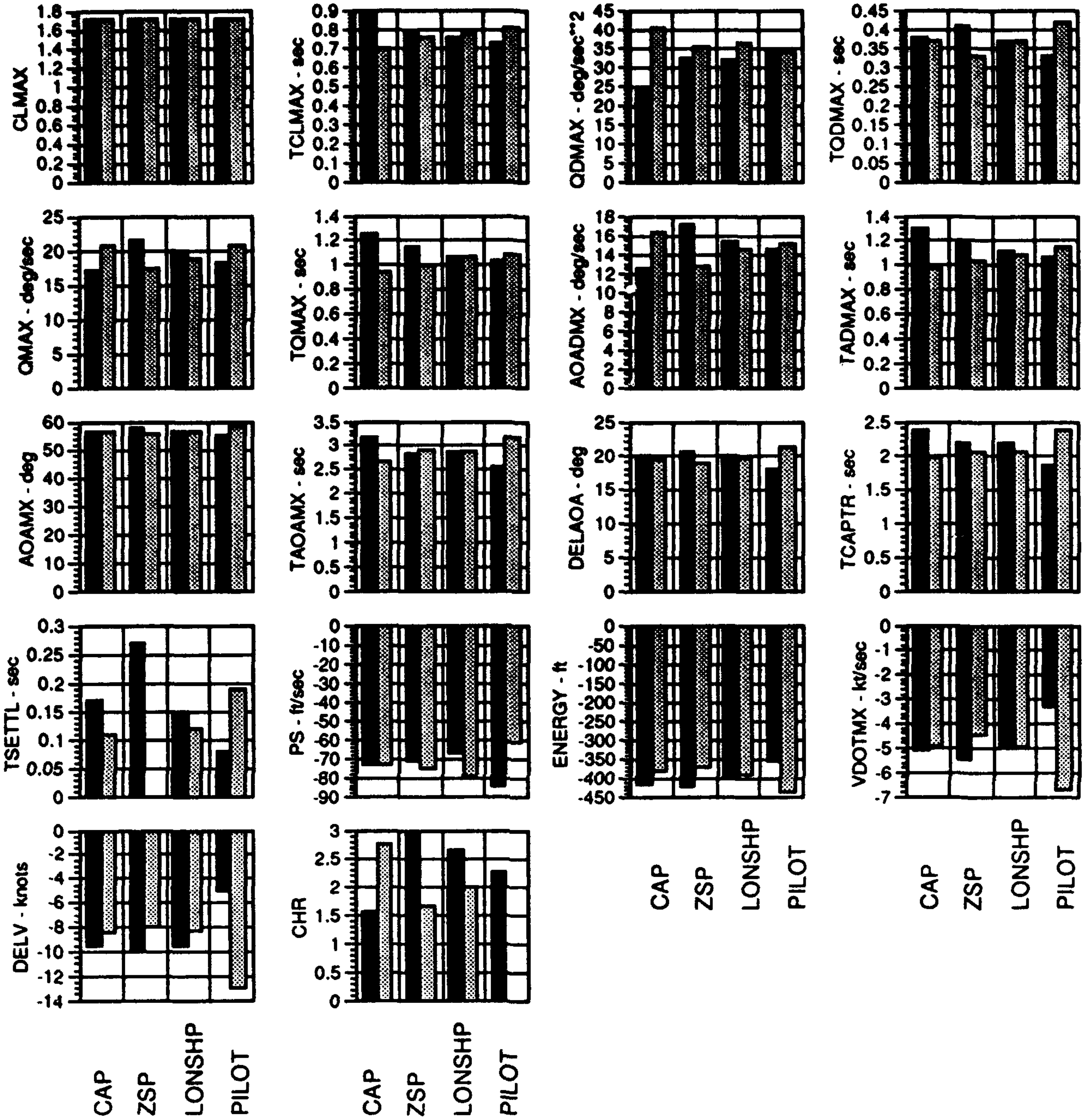
**Test Matrix**

| Lon Config | Lat Config | CAP | ZSP | LONSHP |
|---|---|---|---|---|
| 108 | 2 | 0.28 (-) | 0.35/0.6 (-) | On (+) |
| 153 | 2 | 0.60 (+) | 0.35/0.6 (-) | Off (-) |
| 152 | 2 | 0.28 (-) | 0.70/1.2 (+) | Off (-) |
| 110 | 2 | 0.60 (+) | 0.70/1.2 (+) | On (+) |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | CLMAX | 0.6654 | CAP | 0.970 | 1.72 | 1.7192 | 0 | 0 | 0.000 | 6.00 | 4 | 1 | 4 |
| | | | ZSP | 0.538 | 1.7196 | 1.7193 | 0 | 0 | 0.000 | 2.00 | 4 | 2 | 4 |
| | | | LONSHP | 0.149 | 1.7195 | 1.7194 | 0 | 0 | 0.000 | 1.00 | 4 | 2 | 4 |
| | | | PLT | 0.389 | 1.7194 | 1.7195 | 0 | 0 | 0.000 | | | | |
| 3 | TCLMAX | 0.9999 | CAP | 1.000 | 0.9 | 0.6971 | 0 | 0 | -0.258 | 2.53 | 2 | 1 | 2 |
| | | | ZSP | 0.602 | 0.787 | 0.7588 | 0 | 0 | -0.036 | 0.36 | 4 | 3 | 4 |
| | | | LONSHP | 0.628 | 0.7647 | 0.7801 | 0 | 0 | 0.020 | 0.20 | 4 | 3 | 4 |
| | | | PLT | 0.998 | 0.7341 | 0.8129 | 0 | 0 | 0.102 | | | | |
| 6 | QDMAX | 0.9999 | CAP | 1.000 | 23.702 | 40.136 | 0 | 0 | 0.551 | 32.90 | 1 | 1 | 1 |
| | | | ZSP | 0.854 | 32.413 | 35.556 | 0 | 0 | 0.093 | 5.53 | 4 | 1 | 4 |
| | | | LONSHP | 0.946 | 31.609 | 36.323 | 0 | 0 | 0.139 | 8.32 | 3 | 1 | 3 |
| | | | PLT | 0.413 | 34.299 | 33.729 | 0 | 0 | -0.017 | | | | |
| 7 | TQDMAX | 0.9969 | CAP | 0.184 | 0.375 | 0.3693 | 0 | 0 | -0.015 | 0.06 | 4 | 3 | 4 |
| | | | ZSP | 0.998 | 0.4108 | 0.3338 | 0 | 0 | -0.209 | 0.85 | 2 | 3 | 4 |
| | | | LONSHP | 0.690 | 0.3695 | 0.3733 | 0 | 0 | 0.010 | 0.04 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 0.3273 | 0.4177 | 0 | 0 | 0.246 | | | | |
| 8 | QMAX | 0.9999 | CAP | 1.000 | 17.183 | 20.709 | 0 | 0 | 0.188 | 1.41 | 3 | 2 | 4 |
| | | | ZSP | 1.000 | 21.631 | 17.264 | 0 | 0 | -0.227 | 1.71 | 2 | 2 | 3 |
| | | | LONSHP | 0.074 | 19.97 | 18.849 | 0 | 0 | -0.058 | 0.43 | 4 | 3 | 4 |
| | | | PLT | 0.999 | 18.14 | 20.714 | 0 | 0 | 0.133 | | | | |
| 9 | TQMAX | 0.9999 | CAP | 1.000 | 1.25 | 0.9489 | 0 | 0 | -0.279 | 4.96 | 2 | 1 | 2 |
| | | | ZSP | 1.000 | 1.1394 | 0.9861 | 0 | 0 | -0.145 | 2.58 | 3 | 1 | 3 |
| | | | LONSHP | 0.867 | 1.0647 | 1.0574 | 0 | 0 | -0.007 | 0.12 | 4 | 3 | 4 |
| | | | PLT | 0.998 | 1.0318 | 1.0915 | 0 | 0 | 0.056 | | | | |
| 11 | AOADMX | 0.9999 | CAP | 1.000 | 12.492 | 16.258 | 0 | 0 | 0.267 | 7.35 | 2 | 1 | 2 |
| | | | ZSP | 1.000 | 17.047 | 12.767 | 0 | 0 | -0.293 | 8.08 | 2 | 1 | 2 |
| | | | LONSHP | 0.377 | 15.285 | 14.449 | 0 | 0 | -0.056 | 1.55 | 4 | 2 | 4 |
| | | | PLT | 0.039 | 14.594 | 15.133 | 0 | 0 | 0.036 | | | | |
| 12 | TADMAX | 0.9999 | CAP | 1.000 | 1.3032 | 0.9767 | 0 | 0 | -0.292 | 4.26 | 2 | 1 | 2 |
| | | | ZSP | 1.000 | 1.168 | 1.0316 | 0 | 0 | -0.125 | 1.81 | 3 | 2 | 4 |
| | | | LONSHP | 0.670 | 1.1052 | 1.0915 | 0 | 0 | -0.012 | 0.18 | 4 | 3 | 4 |
| | | | PLT | 0.999 | 1.0614 | 1.1367 | 0 | 0 | 0.069 | | | | |
| 20 | AOAMX | 0.9998 | CAP | 0.273 | 56.657 | 56.351 | 0 | 0 | -0.005 | 0.09 | 4 | 3 | 4 |
| | | | ZSP | 0.966 | 57.42 | 55.554 | 0 | 0 | -0.033 | 0.57 | 4 | 3 | 4 |
| | | | LONSHP | 0.072 | 56.749 | 56.194 | 0 | 0 | -0.010 | 0.17 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 54.863 | 58.143 | 0 | 0 | 0.058 | | | | |
| 21 | TAOAMX | 0.9256 | CAP | 0.916 | 3.1907 | 2.6656 | 0 | 0 | -0.181 | 0.85 | 3 | 3 | 4 |
| | | | ZSP | 0.278 | 2.8132 | 2.9066 | 0 | 0 | 0.033 | 0.15 | 4 | 3 | 4 |
| | | | LONSHP | 0.017 | 2.8552 | 2.8665 | 0 | 0 | 0.004 | 0.02 | 4 | 3 | 4 |
| | | | PLT | 0.974 | 2.5659 | 3.1701 | 0 | 0 | 0.213 | | | | |
| 23 | DELAOA | 0.9994 | CAP | 0.467 | 20.032 | 19.395 | 0 | 0 | -0.032 | 0.19 | 4 | 3 | 4 |
| | | | ZSP | 0.885 | 20.447 | 18.854 | 0 | 0 | -0.081 | 0.48 | 4 | 3 | 4 |
| | | | LONSHP | 0.115 | 19.774 | 19.497 | 0 | 0 | -0.014 | 0.08 | 4 | 3 | 4 |
| | | | PLT | 0.998 | 18.004 | 21.338 | 0 | 0 | 0.171 | | | | |
| 25 | TCAPTR | 0.9547 | CAP | 0.933 | 2.3751 | 1.9489 | 0 | 0 | -0.199 | 0.74 | 3 | 3 | 4 |
| | | | ZSP | 0.457 | 2.1799 | 2.0384 | 0 | 0 | -0.067 | 0.25 | 4 | 3 | 4 |
| | | | LONSHP | 0.371 | 2.1814 | 2.037 | 0 | 0 | -0.069 | 0.26 | 4 | 3 | 4 |
| | | | PLT | 0.987 | 1.8364 | 2.3915 | 0 | 0 | 0.267 | | | | |
| 26 | TSETTL | 0.8372 | CAP | 0.281 | 0.1656 | 0.113 | 0 | 0 | -0.392 | 0.38 | 4 | 3 | 4 |
| | | | ZSP | 0.938 | 0.2714 | 0 | 0 | 0 | 0.000 | 0.00 | 4 | 3 | 4 |
| | | | LONSHP | 0.259 | 0.1452 | 0.1205 | 0 | 0 | -0.188 | 0.18 | 4 | 3 | 4 |
| | | | PLT | 0.549 | 0.0773 | 0.1905 | 0 | 0 | 1.030 | | | | |
| 36 | PS | 0.8763 | CAP | 0.073 | -73.82 | -73.095 | 0 | 0 | 0.010 | 0.03 | 4 | 3 | 4 |
| | | | ZSP | 0.472 | -70.888 | -75.729 | 0 | 0 | -0.066 | 0.21 | 4 | 3 | 4 |
| | | | LONSHP | 0.851 | -67.184 | -79.265 | 0 | 0 | -0.166 | 0.53 | 4 | 3 | 4 |
| | | | PLT | 0.990 | -84.387 | -61.818 | 0 | 0 | 0.316 | | | | |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 37 | ENERGY | 0.4737 | CAP | 0.460 | -417.18 | -381.65 | 0 | 0 | 0.089 | 0.43 | 4 | 3 | 4 |
| | | | ZSP | 0.626 | -420.71 | -370.19 | 0 | 0 | 0.128 | 0.62 | 4 | 3 | 4 |
| | | | LONSHP | 0.151 | -396.42 | -393.38 | 0 | 0 | 0.008 | 0.04 | 4 | 3 | 4 |
| | | | PLT | 0.860 | -355.06 | -436.56 | 0 | 0 | -0.208 | | | | |
| 38 | VDOTMX | 0.9995 | CAP | 0.259 | -5.1091 | -4.8955 | 0 | 0 | 0.043 | 0.06 | 4 | 3 | 4 |
| | | | ZSP | 0.875 | -5.4744 | -4.4983 | 0 | 0 | 0.198 | 0.26 | 4 | 3 | 4 |
| | | | LONSHP | 0.172 | -5.0369 | -4.9159 | 0 | 0 | 0.024 | 0.03 | 4 | 3 | 4 |
| | | | PLT | 1.000 | -3.3114 | -6.7178 | 0 | 0 | -0.768 | | | | |
| 39 | DELV | 0.9999 | CAP | 0.704 | -9.5767 | -8.4955 | 0 | 0 | 0.120 | 0.11 | 4 | 3 | 4 |
| | | | ZSP | 0.919 | -9.8117 | -8.0255 | 0 | 0 | 0.202 | 0.18 | 2 | 3 | 4 |
| | | | LONSHP | 0.525 | -9.4895 | -8.333 | 0 | 0 | 0.130 | 0.12 | 4 | 3 | 4 |
| | | | PLT | 1.000 | -5.0079 | -12.973 | 0 | 0 | -1.102 | | | | |
| 49 | CHR | -999 | CAP | -999.000 | 1.5556 | 2.7692 | 0 | 0 | 0.609 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | ZSP | -999.000 | 3 | 1.6667 | 0 | 0 | -0.622 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LONSHP | -999.000 | 2.6667 | 2 | 0 | 0 | -0.292 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 2.2727 | | 0 | 0 | 0.000 | | | | |

STEM 10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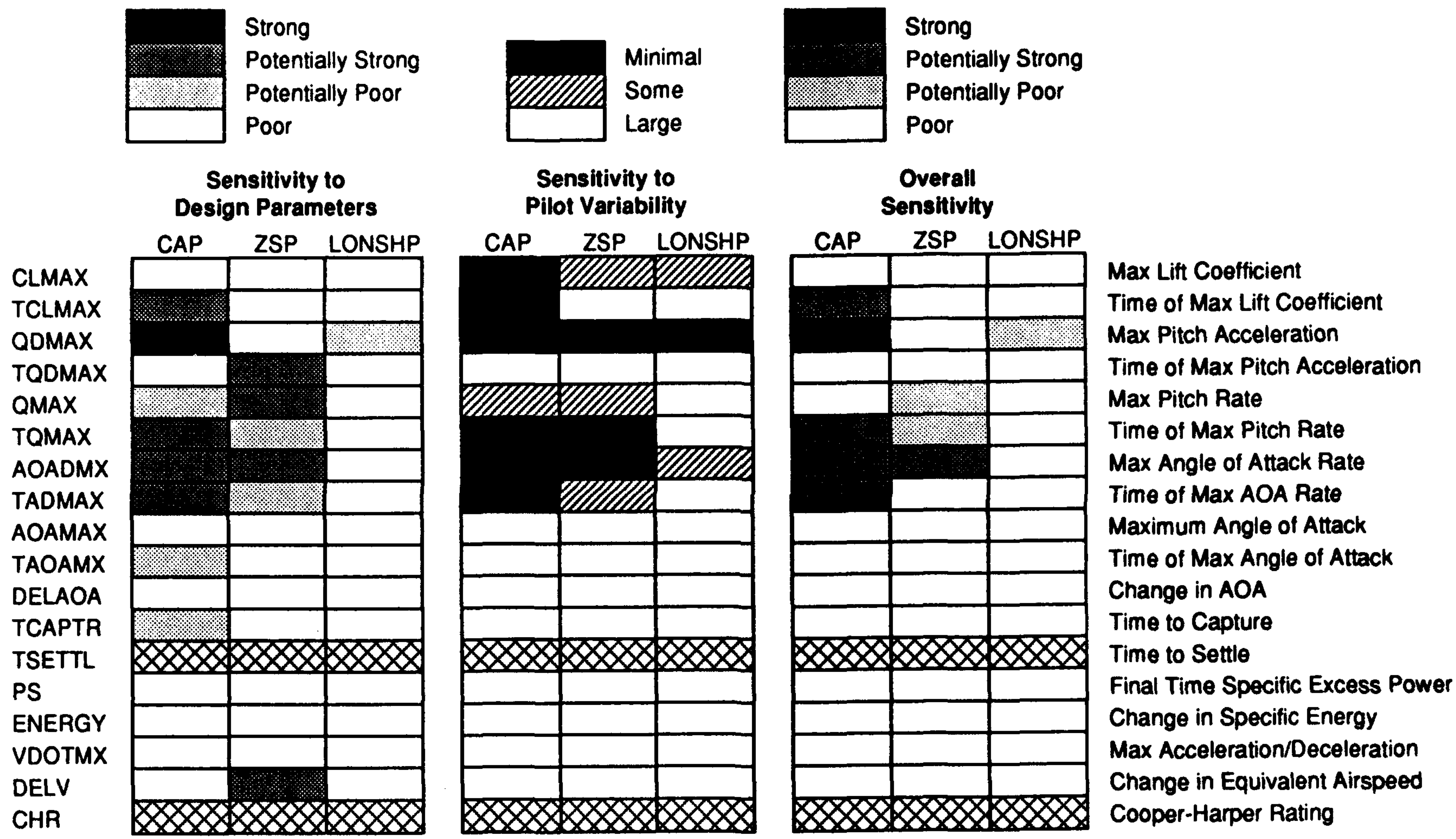
AOAMX - deg
TAOAMX - sec
DELAOA - deg
TCAPTR - sec
TSETTL - sec
PS - ft/sec
ENERGY - ft
VDOTMX - kt/sec
DELV - knots
CHR
CAP
ZSP
LONSHP
PILOT

STEM 10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Potentially Poor
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Sensitivity to Pilot Variability
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ZSP
LONSHP
CAP
ZSP
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ZSP
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VDOTMX
DELV
CHR
Max Lift Coefficient
Time of Max Lift Coefficient
Max Pitch Acceleration
Time of Max Pitch Acceleration
Max Pitch Rate
Time of Max Pitch Rate
Max Angle of Attack Rate
Time of Max AOA Rate
Maximum Angle of Attack
Time of Max Angle of Attack
Change in AOA
Time to Capture
Time to Settle
Final Time Specific Excess Power
Change in Specific Energy
Max Acceleration/Deceleration
Change in Equivalent Airspeed
Cooper-Harper Rating

STEM 10
PILOT A
LONGITUDINAL CONFIGURATION 108
LATERAL CONFIGURATION 11
CHR 2

Its getting there very easily, very predictably. Aggressively as I can do it. Boy this has plane has response just like I'd like. We're really fooling ourselves to some degree because this airplane has no lateral-directional problems. And those would be such a big player under these circumstances. I had some overshoots but they were inside what I need. If I just apply the smallest lead shape it just stops dead on the target. Zero oscillation. The only way I drive into an oscillation is if I hamfist it and try and get there in an instant. Which is not the way you would fly this anyway. Cooper-Harper: Is it controllable? Easily controllable, yes. Is adequate performance attainable with a tolerable pilot workload? Yes. Its never gotten outside of desired. It is satisfactory without improvement? Yes. It was easy to get desired criteria. The way I did this is I set up, I would go just to the aft stick stop, I'd get the nose rate I want, and then I'd start feeding off the nose rates so that I could get to a minimum time track solution. It only took a little bit of compensation. It felt very natural. The airplane came up right away. I'm not sure I could improve on it a lot, just a tiny bit so I would call it good with negligible deficiencies. The pilot compensation was sort of a factor. I had to lead the guy a little bit. The deficiencies were really negligible. I'm not sure that the airplane could have been very much better at all. The compensation that I'm putting in, even though its there, is natural. There were no PIOs so I'm not going to rate it.It had about as much rate as I want considering the nose is moving about 30 degrees. If it was much faster than that, then it would be difficult to control. Maybe it could be a hair faster but not much. But the response is great, I pull back on the stick, the nose immediately ramps up, gives me nice acceleration, the rate is good, it gives me time to smooth out the end game so I get a very steady position on the guy afterwards. So the rate was good and the time to acquire couldn't have been much better because I pulled back on the stick, started easing the stick and I'm on the guy. So, both of them were desirable to highly desirable.

STEM 10
PILOT E
LONGITUDINAL CONFIGURATION 108
LATERAL CONFIGURATION 11

That's not too difficult to do at this particular angle. When you let off the back pressure, you got to put it right back in or you'll undershoot. Capture dynamics are not good for this particular configuration. The rate gets to be pretty large and it's very springy and results in a lot of overshoots unless you're a lot smoother than I am.

STEM 10
PILOT A
LONGITUDINAL CONFIGURATION 153
LATERAL CONFIGURATION 11
CHR 4
PIO 2

A little less predictable in the end game. Very unpredictable to track him. I don't like it because the combination of the aft stick requirement in order to hold the attitude and the rate requirement that I'm requesting by moving the stick don't jive. Basically I have to pulse in the forward stick and then immediately smoothly pull in aft stick, otherwise it bounces off in a PIO that I have trouble controlling. I'm not particularly happy with the flying qualities of this design because I find a contradiction between the aft stick requirement and the way the airplane points itself. You have to do quite a bit of compensation in order to get them to balance out in an acquisition maneuver. It takes more shaping than the last configuration (longitudinal configuration 108). I have to be careful how I release the stick, otherwise I bounce outside the adequate tolerances. Desired performance is possible but it takes considerable pilot compensation. Cooper-Harper: Is it controllable? Yes, never a problem with that. Is adequate performance attainable with a tolerable pilot workload? Yes. I always had adequate performance. Is it satisfactory without improvement? No, deficiencies warrant improvement. I have to work too hard there in order to get a track. Desired performance requires moderate pilot compensation. I have to work, it has minor, annoying deficiencies and those should be fixed. The rates were fine, accelerations were fine, but the handling qualities suffer. PIO Rating scale: Undesired motions tend to occur when pilot initiates abrupt maneuvers. These motions can be prevented or eliminated by pilot technique.

STEM 10
PILOT E
LONGITUDINAL CONFIGURATION 153
LATERAL CONFIGURATION 11

I'm going to have to sneak up on this one to get any kind of a decent capture time. Yeah, that's real difficult to capture. A whole lot of initial pitch rate and then it's too lightly damped for the capture. I'll have to ease it up to him to capture. That was a pretty minimal time capture there. To get a decent capture time, you have to really sneak up on it and just not use full back stick. Then it's pretty easy. Just a matter of getting used to it.

STEM 10
PILOT A
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 11
CHR 1

This is too slow although its very predictable. Thats a pretty heavy airplane. It feels a lot like maybe a Hornet would here in that when you're already at 36 alpha and you're trying to increase to 45 you have to wait. This is not ACM kind of handling qualities, this is standard high alpha sluggish, piggish kind of handling qualities where you have to make allowances for it. Very easy to track of course because the rates are slow

but I wish it were faster. Its a very simple task. Cooper-Harper Rating: Controllable? Easily. Adequate performance? Yes. Is it satisfactory without improvement? We didn't put any time requirement in so I'm purely going to rate the capture task. It is satisfactory without improvement for the capture task. Pilot compensation is not a factor, it is very, very easy to capture this guy. You're at full aft stick, you just ease up on the stick and you're stopped and there's no oscillation. There are no PIOs but it is barely acceptable because of the slow pitch rate. I have to wait 2 or 3 potatoes before I get my nose up 20 degrees. It feels like you're driving a big heavy truck around instead of a fighter, and I want more rate. So maybe you guys should look at the rate we get out of that one, the amount of time to capture versus the rate and time to capture for the other ones. Then a trade off would have to be made between beautiful handling of the capture on this one and the slow time.

STEM 10
PILOT E
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 11

This one is much easier to capture. The pitch rates don't build up quite so badly. With this one I can use full back stick and the rates don't build up so great that it makes it difficult to capture at the other end. It seems to be better damped at the other end to capture him. On that configuration, the rate and the capture dynamics are just about right. The rate is a little bit slow, but the capture dynamics are meshed pretty well to the rate so it's pretty easy to capture the target at the maximum rate that you build up. It's much easier than the other configuration that we had (longitudinal configuration 153/lateral configuration 11). This one has got pretty good dynamics for this task. The rate is fairly quick but its not so fast that you go through it and it stops pretty well just by relaxing the back pressure to match his rate. I guess we got a rate system here or something. It's easier to capture him.

STEM 10
PILOT A
LONGITUDINAL CONFIGURATION 110
LATERAL CONFIGURATION 11
CHR 2

Thats pretty nice. Comes up there fairly snappy. The rate is maybe a hair slow but not bad. And the capture task on the end is pretty good. If you only go to 50 degrees its not bad. There's a quite a change in handling qualities with capture angle of attack. If I push the 55 degree limit then the rate seems to drop off, whereas if I go the 50 limit then the rate is still fairly snappy. I think if I stay inside my band of 50 to 55 degrees its going to be rated a little higher. Little bit slow when I go to 54 to 55 degrees. The capture is very easy, just release some of the back pressure and then it stops where you want. No PIOs, its nice. The rate is not bad, its just a hair slow, its pretty good. Cooper-Harper: It is controllable. I had desired performance every single time. Is it satisfactory without improvement? Yes, it is satisfactory without improvement. I was bouncing well within my desired tolerances every time. It could be very slightly better though. The one previous (longitudinal configuration 152) was even easier to predict than this one. No PIOs. The initial acceleration was good when I pulled back on the stick. The final

rate was maybe just a little slow, and it was dependent on the target angle of attack. If I was targeting 50 degrees it was about where I'd want it, when I was targeting 55 it was just a hair slow. So whatever rate I had at 50 was sort of my minimum threshold of goodness. But the end game handling qualities were excellent. Very predictable. That rate of acceleration and the final rate make the capture task much more predictable. The handling qualities work well with that rate.

STEM 10
PILOT E
LONGITUDINAL CONFIGURATION 110
LATERAL CONFIGURATION 11

Well a little bit squirrelly at the capture. Good pitch rate. Not too bad on the capture. Can use full back stick. It takes a little getting use to but its pretty easy. That's a pretty good set of dynamics there too, you got good pitch rate and fairly good damping on the capture.

**Data Contents for STEM 11: Sharkenhausen**

TEST 1: Maneuver tested at Vc with AOA/Nz command systems
- Summary of Design Parameter Variations Tested
- Numerical Summary of Statistical Analysis
- Bar Graphs of Measures of Merit
- Design Parameter Correlations, Pilot Variability, and Overall Correlations
- Pilot Comments

TEST 2: Maneuver tested at Vmin, with AOA command systems
- Summary of Design Parameter Variations Tested
- Numerical Summary of Statistical Analysis
- Bar Graphs of Measures of Merit
- Design Parameter Correlations, Pilot Variability, and Overall Correlations
- Pilot Comments

TEST 3: Maneuver tested at Vmin, with pitch rate command systems
- Summary of Design Parameter Variations Tested
- Numerical Summary of Statistical Analysis
- Bar Graphs of Measures of Merit
- Design Parameter Correlations, Pilot Variability, and Overall Correlations
- Pilot Comments

TEST 4: Maneuver tested at Vc with AOA/Nz command systems
AOA tested over a smaller range than TEST 1
- Summary of Design Parameter Variations Tested
- Numerical Summary of Statistical Analysis
- Bar Graphs of Measures of Merit
- Design Parameter Correlations, Pilot Variability, and Overall Correlations
- Pilot Comments

TEST 5: Maneuver tested at Vmin, with AOA command systems
AOA tested over a smaller range than TEST 2
- Summary of Design Parameter Variations Tested
- Numerical Summary of Statistical Analysis
- Bar Graphs of Measures of Merit
- Design Parameter Correlations, Pilot Variability, and Overall Correlations
- Pilot Comments

TEST 6: Maneuver tested at Vmin, with AOA rate command systems
- Pilot Comments

## Summary of Design Parameters Tested for STEM 11 TEST 1

Test variables:

LONDYN: Variations in a combination of longitudinal dynamics were implemented. The variations were expected to cover a range of poor and good dynamics:

(-) Poor, (CAP=0.6, ZSP=0.35 for low AOA, ZSP=0.6 for high AOA, no longitudinal stick shaping)

(+) Good, (CAP=0.6, ZSP=0.7 for low AOA, ZSP=1.2 for high AOA, with longitudinal stick shaping)

AOAMAX: Indicates a maximum AOA or load factor depending on flight condition. This also indicates a variation in stick sensitivity:

For low speed (<Vc), maximum AOA set at:

(-) 40°, Aircraft can reach maximum lift but cannot reach post-stall

(+) 70°, Aircraft can be flown post-stall

For high speed (≥Vc), maximum load factor set at:

(-) 7g

(+) 9g

LATDYN: Variations in a combination of lateral dynamics were implemented. The variations were expected to cover a range of poor and good dynamics:

(-) poor, a schedule of TR and PMAX with AOA was implemented based on MIL-STD-1797A and MCAIR high AOA research.

| AOA | TR | PMAX |
|---|---|---|
| 5° | 0.4 sec | 180.0 deg/sec |
| 15° | 0.8 sec | 120.0 deg/sec |
| 30° | 1.8 sec | 50.0 deg/sec |
| 60° | 2.1 sec | 30.0 deg/sec |

(+) good, a schedule of TR and PMAX with AOA was implemented based on MIL-STD-1797A and MCAIR high AOA research.

| AOA | TR | PMAX |
|---|---|---|
| 5° | 0.4 sec | 180.0 deg/sec |
| 15° | 0.6 sec | 150.0 deg/sec |
| 30° | 1.0 sec | 90.0 deg/sec |
| 60° | 1.6 sec | 70.0 deg/sec |

### Test Matrix

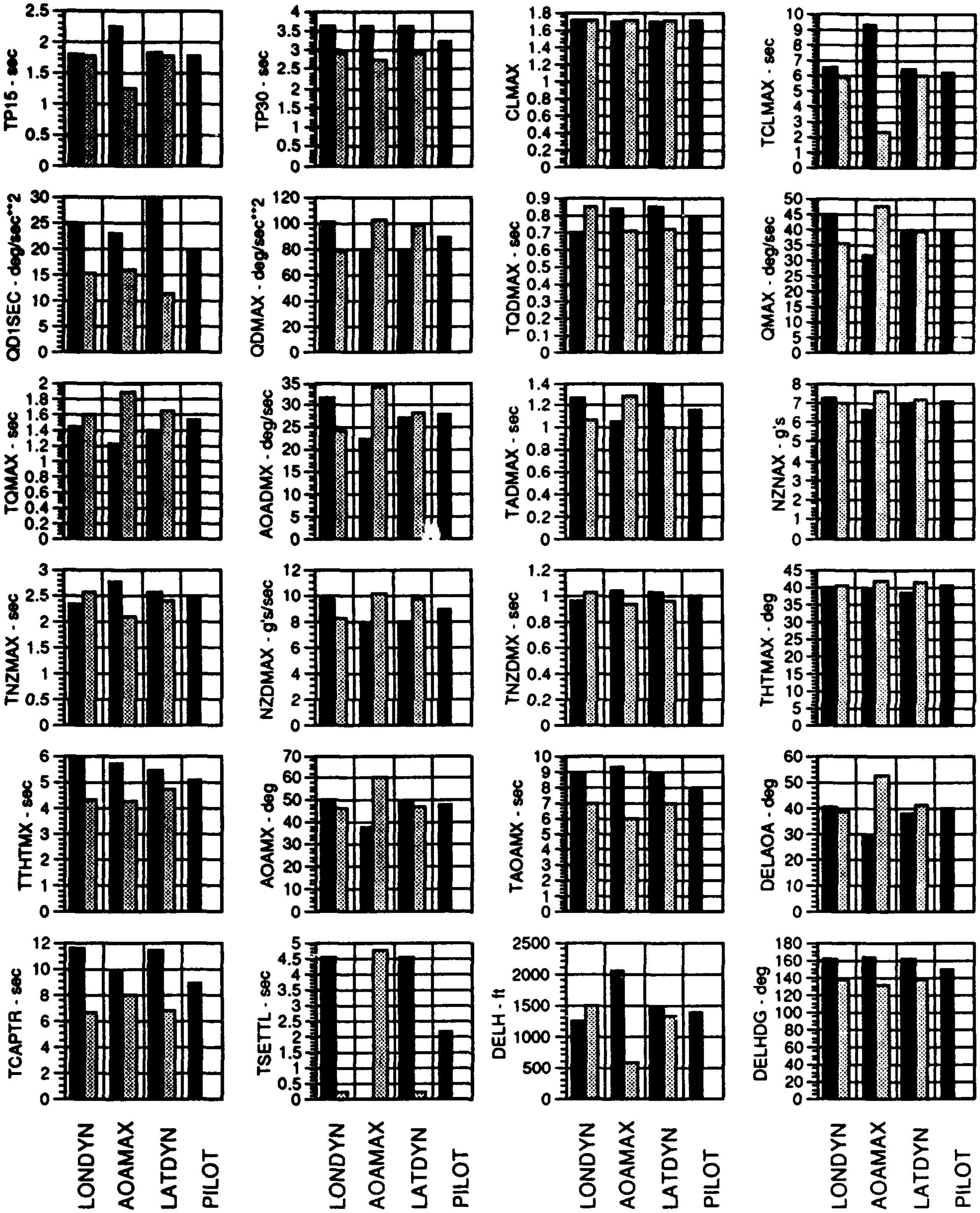
| Lon Config | Lat Config | LONDYN | AOAMAX | LATDYN |
|---|---|---|---|---|
| 101 | 11 | Poor (-) | 7g/40° (-) | Good (+) |
| 126 | 14 | Good (+) | 7g/40° (-) | Poor (-) |
| 153 | 14 | Poor (-) | 9g/70° (+) | Poor (-) |
| 110 | 11 | Good (+) | 9g/70° (+) | Good (+) |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ### | TP15 | 0.8601 | LONDYN | 0.051 | 1.7972 | 1.7731 | 0 | 0 | -0.013 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.972 | 2.2361 | 1.2416 | 0 | 0 | -0.623 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.127 | 1.8105 | 1.762 | 0 | 0 | -0.027 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 1.784 | | 0 | 0 | 0.000 | | | | |
| ### | TP30 | 0.8506 | LONDYN | 0.802 | 3.6172 | 2.9314 | 0 | 0 | -0.212 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.873 | 3.6528 | 2.7516 | 0 | 0 | -0.287 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.826 | 3.6505 | 2.9037 | 0 | 0 | -0.231 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 3.2431 | | 0 | 0 | 0.000 | | | | |
| 2 | CLMAX | 0.9994 | LONDYN | 0.994 | 1.715 | 1.7063 | 0 | 0 | -0.005 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 1.000 | 1.7044 | 1.7172 | 0 | 0 | 0.007 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.995 | 1.704 | 1.7155 | 0 | 0 | 0.007 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 1.7102 | | 0 | 0 | 0.000 | | | | |
| 3 | TCLMAX | 0.9999 | LONDYN | 0.973 | 6.4672 | 5.8898 | 0 | 0 | -0.094 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 1.000 | 9.3445 | 2.3216 | 0 | 0 | -1.888 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.650 | 6.4305 | 5.9203 | 0 | 0 | -0.083 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 6.1522 | | 0 | 0 | 0.000 | | | | |
| ### | QD1SEC | 0.2564 | LONDYN | 0.369 | 24.969 | 15.154 | 0 | 0 | -0.520 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.237 | 22.829 | 15.759 | 0 | 0 | -0.379 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.629 | 29.512 | 11.367 | 0 | 0 | -1.106 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 19.615 | | 0 | 0 | 0.000 | | | | |
| 6 | QDMAX | 0.5222 | LONDYN | 0.627 | 100.58 | 78.168 | 0 | 0 | -0.255 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.727 | 76.712 | 102.33 | 0 | 0 | 0.292 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.475 | 76.961 | 97.851 | 0 | 0 | 0.242 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 88.356 | | 0 | 0 | 0.000 | | | | |
| 7 | TQDMAX | 0.9811 | LONDYN | 0.978 | 0.6972 | 0.8481 | 0 | 0 | 0.197 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.970 | 0.8361 | 0.7116 | 0 | 0 | -0.162 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.908 | 0.8505 | 0.7203 | 0 | 0 | -0.167 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 0.7795 | | 0 | 0 | 0.000 | | | | |
| 8 | QMAX | 0.9666 | LONDYN | 0.871 | 43.504 | 35.229 | 0 | 0 | -0.213 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.990 | 31.677 | 47.767 | 0 | 0 | 0.422 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.338 | 38.699 | 39.234 | 0 | 0 | 0.014 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 38.99 | | 0 | 0 | 0.000 | | | | |
| 9 | TQMAX | 0.6264 | LONDYN | 0.339 | 1.4272 | 1.5981 | 0 | 0 | 0.113 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.883 | 1.2111 | 1.8916 | 0 | 0 | 0.461 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.362 | 1.3905 | 1.6287 | 0 | 0 | 0.159 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 1.5204 | | 0 | 0 | 0.000 | | | | |
| 11 | AOADMX | 0.8667 | LONDYN | 0.803 | 31.865 | 24.237 | 0 | 0 | -0.277 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.953 | 22.237 | 34.265 | 0 | 0 | 0.446 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.144 | 27.057 | 28.243 | 0 | 0 | 0.043 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 27.704 | | 0 | 0 | 0.000 | | | | |
| 12 | TADMAX | 0.8041 | LONDYN | 0.607 | 1.2672 | 1.0731 | 0 | 0 | -0.167 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.737 | 1.0528 | 1.2916 | 0 | 0 | 0.206 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.909 | 1.3605 | 0.9953 | 0 | 0 | -0.318 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 1.1613 | | 0 | 0 | 0.000 | | | | |
| 14 | NZMAX | 0.9999 | LONDYN | 0.994 | 7.3004 | 6.9496 | 0 | 0 | -0.049 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 1.000 | 6.6632 | 7.6441 | 0 | 0 | 0.138 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.340 | 7.006 | 7.1949 | 0 | 0 | 0.027 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 7.1091 | | 0 | 0 | 0.000 | | | | |
| 15 | TNZMAX | 0.7057 | LONDYN | 0.513 | 2.3172 | 2.5648 | 0 | 0 | 0.102 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.913 | 2.7445 | 2.1016 | 0 | 0 | -0.270 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.144 | 2.5405 | 2.3787 | 0 | 0 | -0.066 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 2.4522 | | 0 | 0 | 0.000 | | | | |
| 16 | NZDMAX | 0.6375 | LONDYN | 0.613 | 9.6328 | 8.1758 | 0 | 0 | -0.165 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.817 | 7.8485 | 10.026 | 0 | 0 | 0.247 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.573 | 7.8989 | 9.6207 | 0 | 0 | 0.198 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 8.8381 | | 0 | 0 | 0.000 | | | | |

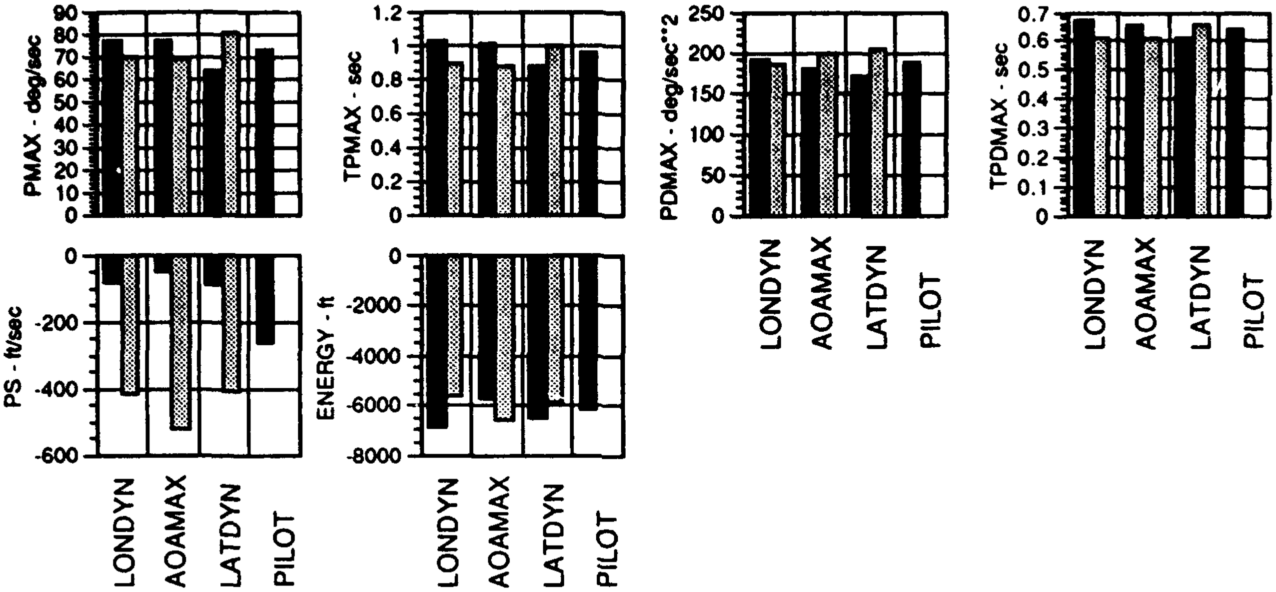
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17 | TNZDMX | 0.8453 | LONDYN | 0.806 | 0.9472 | 1.0231 | 0 | 0 | 0.077 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.930 | 1.0361 | 0.9316 | 0 | 0 | -0.107 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.514 | 1.0205 | 0.962 | 0 | 0 | -0.059 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 0.9886 | | 0 | 0 | 0.000 | | | | |
| 18 | THTMAX | 0.9705 | LONDYN | 0.444 | 39.773 | 40.389 | 0 | 0 | 0.015 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.967 | 38.886 | 41.576 | 0 | 0 | 0.067 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.980 | 38.361 | 41.565 | 0 | 0 | 0.080 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 40.109 | | 0 | 0 | 0.000 | | | | |
| 19 | TTHTMX | 0.9957 | LONDYN | 0.997 | 5.9372 | 4.2814 | 0 | 0 | -0.333 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.988 | 5.6945 | 4.2416 | 0 | 0 | -0.299 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.928 | 5.4605 | 4.6787 | 0 | 0 | -0.155 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 5.034 | | 0 | 0 | 0.000 | | | | |
| 20 | AOAMX | 0.9999 | LONDYN | 0.997 | 50.461 | 46.167 | 0 | 0 | -0.089 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 1.000 | 38.172 | 60.054 | 0 | 0 | 0.469 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.999 | 49.353 | 47.09 | 0 | 0 | -0.047 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 48.119 | | 0 | 0 | 0.000 | | | | |
| 21 | TAOAMX | 0.9994 | LONDYN | 0.993 | 8.8172 | 6.9398 | 0 | 0 | -0.242 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 1.000 | 9.3195 | 5.9616 | 0 | 0 | -0.462 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.987 | 8.7705 | 6.9787 | 0 | 0 | -0.231 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 7.7931 | | 0 | 0 | 0.000 | | | | |
| 23 | DELAOA | 0.9999 | LONDYN | 0.646 | 40.497 | 38.737 | 0 | 0 | -0.044 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 1.000 | 29.012 | 52.167 | 0 | 0 | 0.621 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.115 | 37.883 | 40.915 | 0 | 0 | 0.077 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 39.537 | | 0 | 0 | 0.000 | | | | |
| 25 | TCAPTR | 0.8427 | LONDYN | 0.888 | 11.597 | 6.6564 | 0 | 0 | -0.584 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.333 | 9.6778 | 7.9716 | 0 | 0 | -0.195 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.900 | 11.481 | 6.7537 | 0 | 0 | -0.556 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 8.9022 | | 0 | 0 | 0.000 | | | | |
| 26 | TSETTL | 0.8946 | LONDYN | 0.822 | 4.56 | 0.1833 | 0 | 0 | -12.416 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.884 | 0 | 4.78 | 0 | 0 | 0.000 | #NUM! | 4 | #NUM! | #NUM! |
| | | | LATDYN | 0.896 | 4.56 | 0.1833 | 0 | 0 | -12.416 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 2.1727 | | 0 | 0 | 0.000 | | | | |
| ### | DELH | 0.9868 | LONDYN | 0.545 | 1232.6 | 1486 | 0 | 0 | 0.188 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.998 | 2041.5 | 566 | 0 | 0 | -1.665 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.189 | 1432.5 | 1319.4 | 0 | 0 | -0.082 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 1370.8 | | 0 | 0 | 0.000 | | | | |
| 28 | DELHDG | 0.9969 | LONDYN | 0.987 | 161.87 | 137.77 | 0 | 0 | -0.162 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.996 | 163.97 | 130.42 | 0 | 0 | -0.231 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.982 | 161.45 | 138.12 | 0 | 0 | -0.157 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 148.72 | | 0 | 0 | 0.000 | | | | |
| ### | PMAX | 0.7679 | LONDYN | 0.581 | 76.927 | 69.457 | 0 | 0 | -0.102 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.608 | 76.784 | 68.135 | 0 | 0 | -0.120 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.910 | 63.677 | 80.498 | 0 | 0 | 0.237 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 72.852 | | 0 | 0 | 0.000 | | | | |
| 31 | TPMAX | 0.9888 | LONDYN | 0.976 | 1.0172 | 0.8898 | 0 | 0 | -0.134 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.976 | 1.0111 | 0.8716 | 0 | 0 | -0.149 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.974 | 0.8805 | 1.0037 | 0 | 0 | 0.131 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 0.9477 | | 0 | 0 | 0.000 | | | | |
| 32 | PDMAX | 0.3329 | LONDYN | 0.161 | 191.48 | 185.39 | 0 | 0 | -0.032 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.478 | 179.63 | 198.39 | 0 | 0 | 0.099 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.678 | 170.05 | 203.24 | 0 | 0 | 0.179 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 188.16 | | 0 | 0 | 0.000 | | | | |
| 33 | TPDMAX | 0.7548 | LONDYN | 0.793 | 0.6672 | 0.6148 | 0 | 0 | -0.082 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.725 | 0.6611 | 0.6116 | 0 | 0 | -0.078 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.789 | 0.6105 | 0.662 | 0 | 0 | 0.081 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 0.6386 | | 0 | 0 | 0.000 | | | | |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 36 | PS | 0.9977 | LONDYN | 0.989 | -80.607 | -417.09 | 0 | 0 | -2.491 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.997 | -47.875 | -523.66 | 0 | 0 | -5.423 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.985 | -87.065 | -411.7 | 0 | 0 | -2.259 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | -264.14 | | 0 | 0 | 0.000 | | | | |
| 37 | ENERGY | 0.9842 | LONDYN | 0.983 | -6849.7 | -5593.1 | 0 | 0 | 0.204 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.961 | -5755.2 | -6655.3 | 0 | 0 | -0.146 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.944 | -6534.4 | -5855.9 | 0 | 0 | 0.110 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | -6164.3 | | 0 | 0 | 0.000 | | | | |

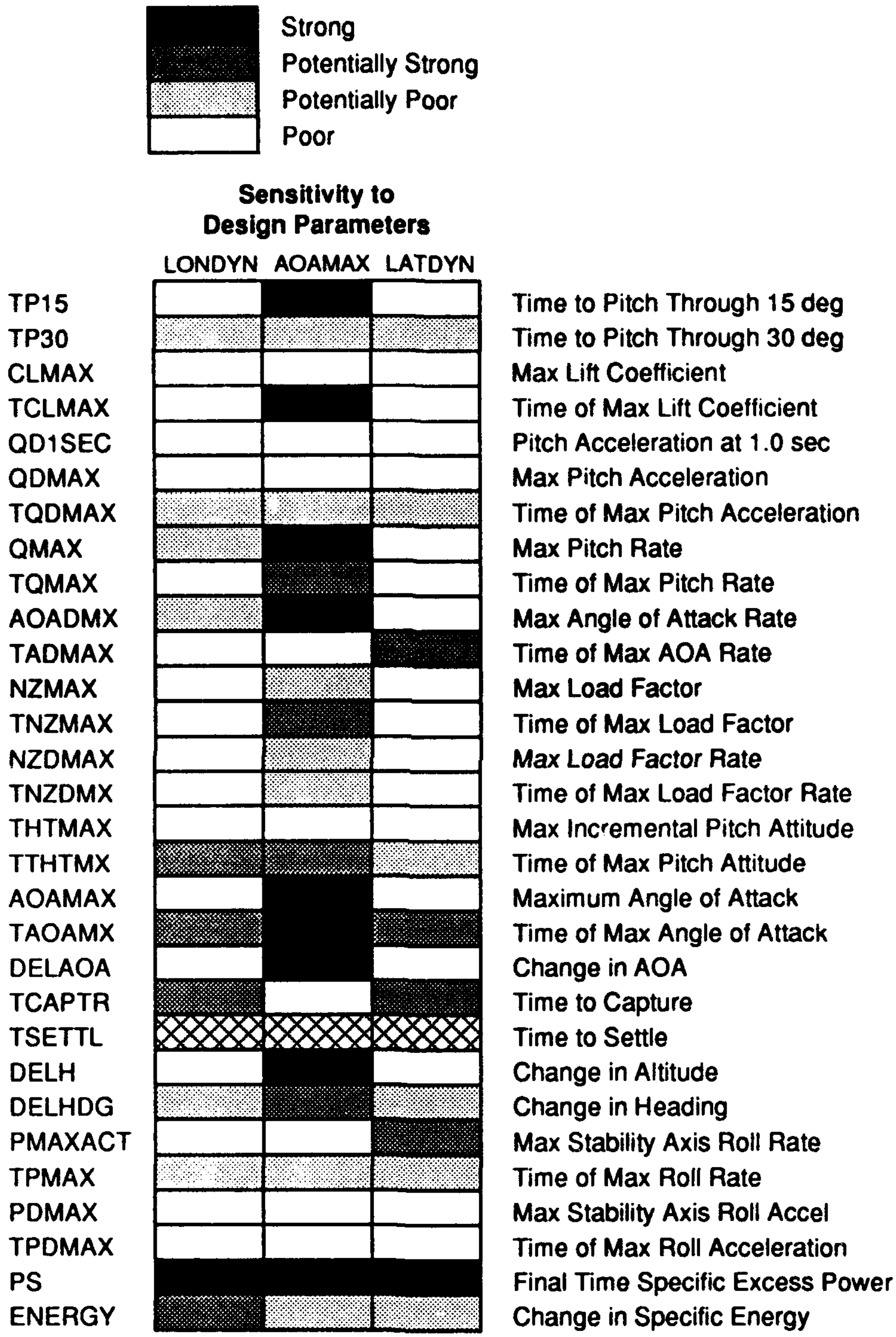
STEM 11 TEST 1



STEM 11 TEST 1



STEM 11 TEST 1




Note: Data available for only a single pilot, therefore, sensitivity to pilot variability and overall sensitivity not shown.

STEM 11 TEST 1
PILOT F
LONGITUDINAL CONFIGURATION 101
LATERAL CONFIGURATION 11

This one is extremely slow. The key to one without much pitch rate is to not turn too much nose high. This thing is real sluggish. I am not getting over 30 degrees here. It looks like to me roll and pitch are pretty well blended. It's just that the alpha is limited. I'm not having to compensate either way on this configuration.

STEM 11 TEST 1
PILOT F
LONGITUDINAL CONFIGURATION 126
LATERAL CONFIGURATION 14

This feels like the last one (longitudinal configuration 101/lateral configuration 11) except that the nose is a lot more stable. This configuration doesn't feel a whole lot different than the last one. I don't have to compensate either for roll or for pitch because the thing is moving so slow. If I do compensate, I have plenty of time to do it. Fairly stable tracking.

STEM 11 TEST 1
PILOT F
LONGITUDINAL CONFIGURATION 153
LATERAL CONFIGURATION 14

That time I went with a real rapid nose pitch up, then I lost energy, lost nose control, the nose dropped below him, and so now I have to start flying my velocity vector again to get back up. This one is so squirrelly in roll that I'm falling off real quick. I come up and put my nose on him and my pipper is below him before I know it. I'm getting to 60 alpha real quick. High alpha roll is really sensitive. It's waffling back and forth. It is almost like throwing a ball at a target. That's how ballistic it feels when you start the nose up. I caught him early that time, but once the motion starts, that's where the nose is going. So you have to anticipate it from the pull, because if you're off on the pull you can't correct it once it gets going. Seems like it is extremely sensitive in pitch and roll. Pitch is not bad. It is controllable. I just run out of energy too quick.

STEM 11 TEST 1
PILOT F
LONGITUDINAL CONFIGURATION 110
LATERAL CONFIGURATION 11

Seems like it has nicely controlled roll and the pitch authority is real high also. So I'm not fishing in roll when I go up. This one is nice. Nice control. I'm not having a roll off in a turn. In other words when I roll in and I stop it, it captures. It doesn't just keep on going, and I'm not having to guess where it's going to be at. So I don't have to throw the pipper up towards him without touching any lateral once it starts pitching. I'm going to try one really aggressive this time. See I can even control it in maximum deflection.

## Summary of Design Parameters Tested for STEM 11 TEST 2

Test variables:

LONDYN: Variations in a combination of longitudinal dynamics were implemented. The variations were expected to cover a range of poor and good dynamics:

(-) Poor, (CAP=0.6/$\omega_{sp}$=1.067 at 100 KEAS, ZSP=0.35 for low AOA, ZSP=0.6 for high AOA, no longitudinal stick shaping)

(+) Good, (CAP=0.6/$\omega_{sp}$=1.067, ZSP=0.7 for low AOA, ZSP=1.2 for high AOA, with longitudinal stick shaping)

AOAMAX: Indicates a maximum AOA or load factor depending on flight condition. This also indicates a variation in stick sensitivity:

For low speed (<Vc), maximum AOA set at:

(-) 40°, Aircraft can reach maximum lift but cannot reach post-stall

(+) 70°, Aircraft can be flown post-stall

For high speed (≥Vc), maximum load factor set at:

(-) 7g

(+) 9g

LATDYN: Variations in a combination of lateral dynamics were implemented. The variations were expected to cover a range of poor and good dynamics:

(-) poor, a schedule of TR and PMAX with AOA was implemented based on MIL-STD-1797A and MCAIR high AOA research.

| AOA | TR | PMAX |
|---|---|---|
| 5° | 0.4 sec | 180.0 deg/sec |
| 15° | 0.8 sec | 120.0 deg/sec |
| 30° | 1.8 sec | 50.0 deg/sec |
| 60° | 2.1 sec | 30.0 deg/sec |

(+) good, a schedule of TR and PMAX with AOA was implemented based on MIL-STD-1797A and MCAIR high AOA research.

| AOA | TR | PMAX |
|---|---|---|
| 5° | 0.4 sec | 180.0 deg/sec |
| 15° | 0.6 sec | 150.0 deg/sec |
| 30° | 1.0 sec | 90.0 deg/sec |
| 60° | 1.6 sec | 70.0 deg/sec |

### Test Matrix

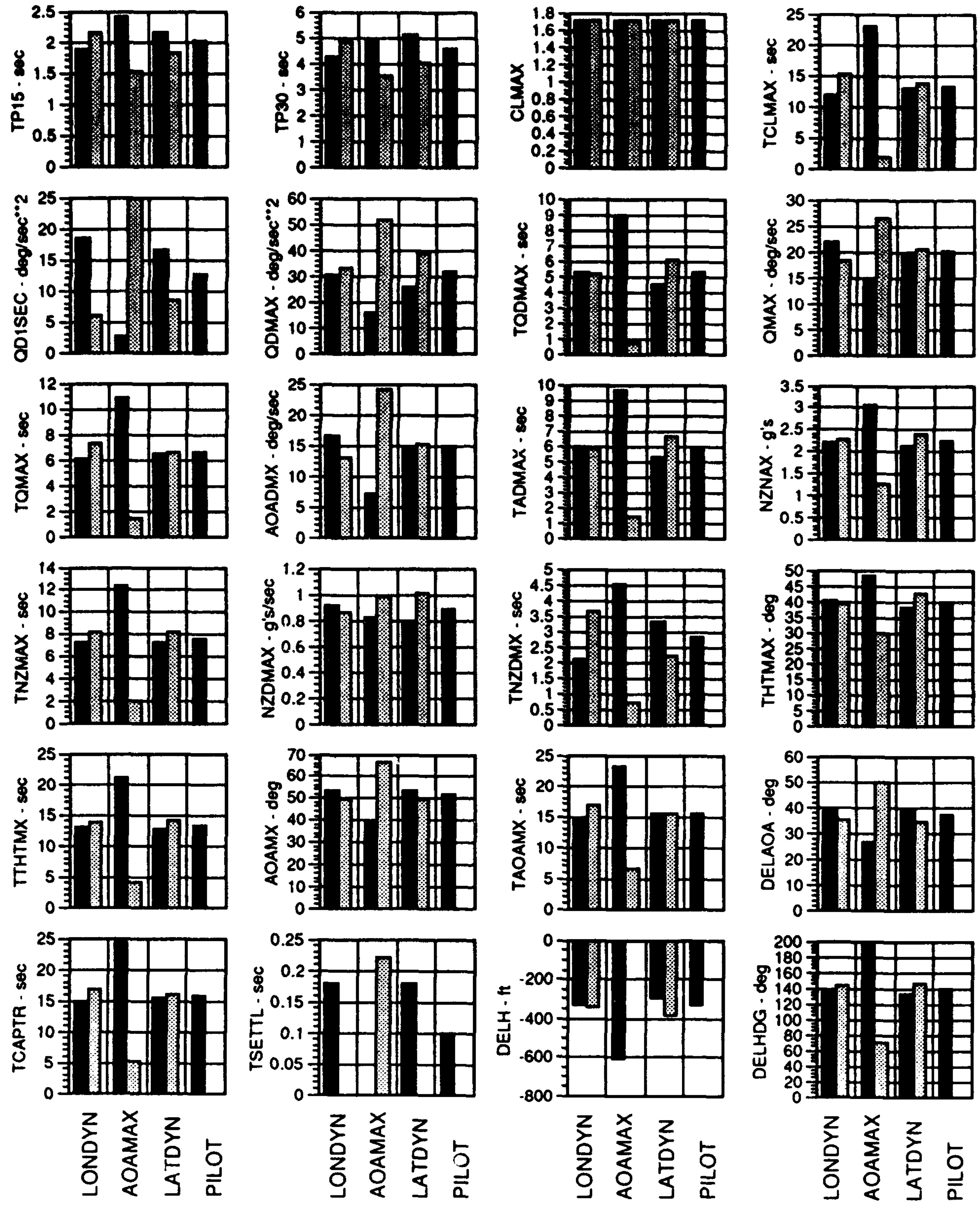
| Lon Config | Lat Config | LONDYN | AOAMAX | LATDYN |
|---|---|---|---|---|
| 101 | 11 | Poor (-) | 7g/40° (-) | Good (+) |
| 126 | 14 | Good (+) | 7g/40° (-) | Poor (-) |
| 153 | 14 | Poor (-) | 9g/70° (+) | Poor (-) |
| 110 | 11 | Good (+) | 9g/70° (+) | Good (+) |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ### | TP15 | 0.9756 | LONDYN | 0.721 | 1.8826 | 2.1565 | 0 | 0 | 0.136 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.992 | 2.4097 | 1.524 | 0 | 0 | -0.474 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.862 | 2.1521 | 1.8331 | 0 | 0 | -0.161 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 2.0071 | | 0 | 0 | 0.000 | | | | |
| ### | TP30 | 0.4613 | LONDYN | 0.423 | 4.246 | 4.8716 | 0 | 0 | 0.138 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.706 | 4.9181 | 3.4809 | 0 | 0 | -0.353 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.549 | 5.0876 | 4.0299 | 0 | 0 | -0.235 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 4.5588 | | 0 | 0 | 0.000 | | | | |
| 2 | CLMAX | 0.2399 | LONDYN | 0.523 | 1.7184 | 1.7164 | 0 | 0 | -0.001 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.065 | 1.7173 | 1.7177 | 0 | 0 | 0.000 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.542 | 1.7165 | 1.7187 | 0 | 0 | 0.001 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 1.7175 | | 0 | 0 | 0.000 | | | | |
| 3 | TCLMAX | 0.9999 | LONDYN | 0.968 | 11.824 | 15.047 | 0 | 0 | 0.243 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 1.000 | 22.843 | 1.824 | 0 | 0 | -6.222 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.629 | 12.91 | 13.743 | 0 | 0 | 0.063 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 13.289 | | 0 | 0 | 0.000 | | | | |
| ### | QD1SEC | 0.9983 | LONDYN | 0.988 | 18.436 | 6.0284 | 0 | 0 | -1.366 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.999 | 2.7016 | 24.91 | 0 | 0 | 4.556 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.903 | 16.472 | 8.3845 | 0 | 0 | -0.728 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 12.796 | | 0 | 0 | 0.000 | | | | |
| 6 | QDMAX | 0.9999 | LONDYN | 0.530 | 30.57 | 33.406 | 0 | 0 | 0.089 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 1.000 | 15.42 | 51.585 | 0 | 0 | 1.523 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.998 | 25.762 | 39.175 | 0 | 0 | 0.432 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 31.859 | | 0 | 0 | 0.000 | | | | |
| 7 | TQDMAX | 0.9999 | LONDYN | 0.210 | 5.2993 | 5.1865 | 0 | 0 | -0.022 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 1.000 | 9.0097 | 0.7339 | 0 | 0 | -6.097 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.861 | 4.5187 | 6.1231 | 0 | 0 | 0.309 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 5.248 | | 0 | 0 | 0.000 | | | | |
| 8 | QMAX | 0.9974 | LONDYN | 0.913 | 21.838 | 18.151 | 0 | 0 | -0.186 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 1.000 | 14.941 | 26.428 | 0 | 0 | 0.602 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.587 | 19.831 | 20.56 | 0 | 0 | 0.036 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 20.162 | | 0 | 0 | 0.000 | | | | |
| 9 | TQMAX | 0.9983 | LONDYN | 0.619 | 6.016 | 7.2965 | 0 | 0 | 0.194 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 1.000 | 10.868 | 1.474 | 0 | 0 | -3.619 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.401 | 6.5271 | 6.6831 | 0 | 0 | 0.024 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 6.598 | | 0 | 0 | 0.000 | | | | |
| 11 | AOADMX | 0.9999 | LONDYN | 0.942 | 16.489 | 12.921 | 0 | 0 | -0.246 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 1.000 | 7.16 | 24.115 | 0 | 0 | 1.536 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.765 | 14.624 | 15.158 | 0 | 0 | 0.036 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 14.867 | | 0 | 0 | 0.000 | | | | |
| 12 | TADMAX | 0.9999 | LONDYN | 0.234 | 5.9493 | 5.8065 | 0 | 0 | -0.024 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 1.000 | 9.6181 | 1.404 | 0 | 0 | -3.352 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.637 | 5.2604 | 6.6331 | 0 | 0 | 0.234 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 5.8844 | | 0 | 0 | 0.000 | | | | |
| 14 | NZMAX | 0.9999 | LONDYN | 0.322 | 2.2087 | 2.2823 | 0 | 0 | 0.033 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 1.000 | 3.0501 | 1.2726 | 0 | 0 | -0.990 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.305 | 2.1249 | 2.3828 | 0 | 0 | 0.115 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 2.2421 | | 0 | 0 | 0.000 | | | | |
| 15 | TNZMAX | 0.9999 | LONDYN | 0.900 | 7.191 | 8.1565 | 0 | 0 | 0.126 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 1.000 | 12.376 | 1.934 | 0 | 0 | -3.122 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.142 | 7.1937 | 8.1531 | 0 | 0 | 0.126 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 7.6298 | | 0 | 0 | 0.000 | | | | |
| 16 | NZDMAX | 0.15 | LONDYN | 0.140 | 0.9204 | 0.8616 | 0 | 0 | -0.066 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.354 | 0.8213 | 0.9805 | 0 | 0 | 0.178 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.508 | 0.7941 | 1.0132 | 0 | 0 | 0.246 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 0.8937 | | 0 | 0 | 0.000 | | | | |

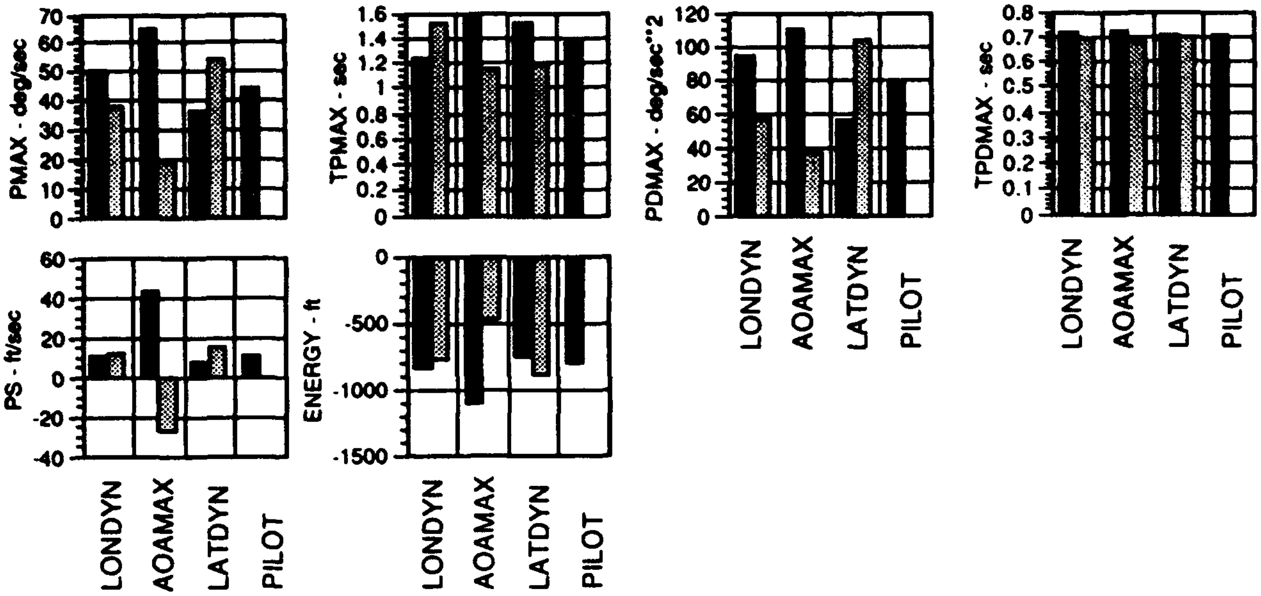
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17 | TNZDMX | 0.5439 | LONDYN | 0.445 | 2.1076 | 3.6265 | 0 | 0 | 0.570 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.822 | 4.5264 | 0.7239 | 0 | 0 | -3.046 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.404 | 3.2937 | 2.2031 | 0 | 0 | -0.413 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 2.798 | | 0 | 0 | 0.000 | | | | |
| 18 | THTMAX | 0.9977 | LONDYN | 0.201 | 40.217 | 39.473 | 0 | 0 | -0.019 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 1.000 | 48.082 | 30.036 | 0 | 0 | -0.488 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.576 | 37.854 | 42.309 | 0 | 0 | 0.111 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 39.879 | | 0 | 0 | 0.000 | | | | |
| 19 | TTHTMX | 0.9999 | LONDYN | 0.560 | 12.858 | 13.797 | 0 | 0 | 0.071 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 1.000 | 21.026 | 3.994 | 0 | 0 | -2.537 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.275 | 12.66 | 14.033 | 0 | 0 | 0.103 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 13.284 | | 0 | 0 | 0.000 | | | | |
| 20 | AOAMX | 0.9999 | LONDYN | 0.999 | 53.671 | 49.547 | 0 | 0 | -0.080 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 1.000 | 39.536 | 66.509 | 0 | 0 | 0.544 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.782 | 53.439 | 49.825 | 0 | 0 | -0.070 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 51.796 | | 0 | 0 | 0.000 | | | | |
| 21 | TAOAMX | 0.9999 | LONDYN | 0.870 | 14.491 | 16.807 | 0 | 0 | 0.149 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 1.000 | 23.101 | 6.474 | 0 | 0 | -1.644 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.712 | 15.519 | 15.573 | 0 | 0 | 0.003 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 15.544 | | 0 | 0 | 0.000 | | | | |
| 23 | DELAOA | 0.9999 | LONDYN | 0.964 | 38.665 | 35.283 | 0 | 0 | -0.092 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 1.000 | 26.383 | 50.022 | 0 | 0 | 0.684 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.875 | 39.176 | 34.67 | 0 | 0 | -0.122 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 37.128 | | 0 | 0 | 0.000 | | | | |
| 25 | TCAPTR | 0.9999 | LONDYN | 0.903 | 14.766 | 16.817 | 0 | 0 | 0.130 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 1.000 | 24.368 | 5.294 | 0 | 0 | -2.193 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.656 | 15.327 | 16.143 | 0 | 0 | 0.052 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 15.698 | | 0 | 0 | 0.000 | | | | |
| 26 | TSETTL | 0.4901 | LONDYN | 0.598 | 0.1833 | 0 | 0 | 0 | 0.000 | #NUM! | 4 | #NUM! | #NUM! |
| | | | AOAMAX | 0.643 | 0 | 0.22 | 0 | 0 | 0.000 | #NUM! | 4 | #NUM! | #NUM! |
| | | | LATDYN | 0.593 | 0.1833 | 0 | 0 | 0 | 0.000 | #NUM! | 4 | #NUM! | #NUM! |
| | | | PLT | -999.000 | 0.1 | | 0 | 0 | 0.000 | | | | |
| ### | DELH | 0.9051 | LONDYN | 0.030 | -331.35 | -339 | 0 | 0 | -0.023 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.982 | -611.87 | -2.3797 | 0 | 0 | 128.558 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.092 | -293.75 | -384.12 | 0 | 0 | -0.271 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | -334.83 | | 0 | 0 | 0.000 | | | | |
| 28 | DELHDG | 0.9999 | LONDYN | 0.961 | 135.43 | 143.54 | 0 | 0 | 0.058 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 1.000 | 196.08 | 70.767 | 0 | 0 | -1.205 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.087 | 133.36 | 146.02 | 0 | 0 | 0.091 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 139.12 | | 0 | 0 | 0.000 | | | | |
| ### | PMAX | 0.996 | LONDYN | 0.812 | 49.982 | 37.61 | 0 | 0 | -0.288 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.999 | 65.275 | 19.259 | 0 | 0 | -1.547 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.788 | 36.168 | 54.186 | 0 | 0 | 0.415 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 44.358 | | 0 | 0 | 0.000 | | | | |
| 31 | TPMAX | 0.9309 | LONDYN | 0.856 | 1.241 | 1.5265 | 0 | 0 | 0.209 | #DIV/0! | 3 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.930 | 1.5514 | 1.154 | 0 | 0 | -0.300 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.911 | 1.5187 | 1.1931 | 0 | 0 | -0.244 | #DIV/0! | 2 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 1.3707 | | 0 | 0 | 0.000 | | | | |
| 32 | PDMAX | 0.9969 | LONDYN | 0.956 | 93.968 | 57.245 | 0 | 0 | -0.516 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.999 | 110.65 | 37.23 | 0 | 0 | -1.318 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.956 | 55.251 | 103.7 | 0 | 0 | 0.672 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 77.275 | | 0 | 0 | 0.000 | | | | |
| 33 | TPDMAX | 0.4686 | LONDYN | 0.624 | 0.7243 | 0.6865 | 0 | 0 | -0.054 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.716 | 0.7264 | 0.6839 | 0 | 0 | -0.060 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.305 | 0.7104 | 0.7031 | 0 | 0 | -0.010 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 0.7071 | | 0 | 0 | 0.000 | | | | |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 36 | PS | 0.9999 | LONDYN | 0.382 | 10.207 | 11.67 | 0 | 0 | 0.134 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 1.000 | 42.896 | -27.558 | 0 | 0 | -2.100 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.164 | 7.1171 | 15.377 | 0 | 0 | 0.849 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 10.872 | | 0 | 0 | 0.000 | | | | |
| 37 | ENERGY | 0.9534 | LONDYN | 0.292 | -845.37 | -777.3 | 0 | 0 | 0.084 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | AOAMAX | 0.992 | -1098.4 | -473.64 | 0 | 0 | 0.944 | #DIV/0! | 1 | #DIV/0! | #DIV/0! |
| | | | LATDYN | 0.224 | -756.28 | -884.2 | 0 | 0 | -0.157 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | -814.43 | | 0 | 0 | 0.000 | | | | |

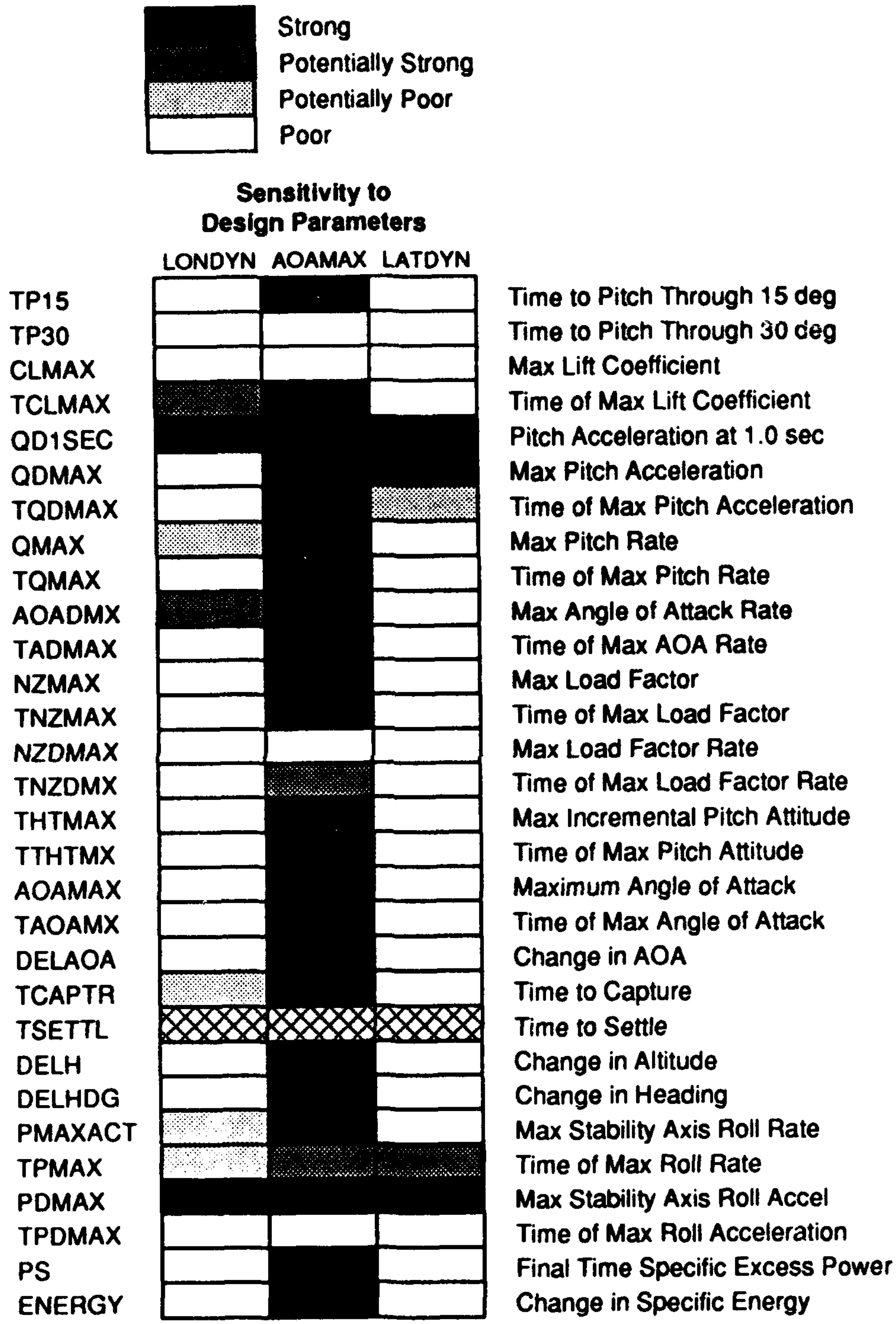
STEM 11 TEST 2



STEM 11 TEST 2



STEM 11 TEST 2




Note: Data available for only a single pilot,
therefore, sensitivity to pilot variability and overall sensitivity not shown.

STEM 11 TEST 2
PILOT C
LONGITUDINAL CONFIGURATION 101
LATERAL CONFIGURATION 11

The lateral is going to be sporty enough that you can PIO. I can't just yank those up to him. I've got to do something a little more intelligent. I'm going to have to look at yo-yo this one too. Same thing. You're just coming around in a circle. A stern chase is a long chase. So what do we have? Well we have some configurations where we can't do what we want to do. We have the guy up there and we can't bank into him and pull up to him. The only thing we can do is trying to get some speed back and follow him around in a circle. The smart thing to do in this case is probably put the nose straight ahead and run for it and hope he hasn't seen. You're going to have to do something to get your speed up, because you can't just pull the nose up. This configuration has better angle of attack capability. The basic technique is the same as the previous one (longitudinal configuration 126/lateral configuration 11). You need to do a low yo-yo to about 210 or 220 knots. Then follow him around the circle and you're basically going to catch him in a stern chase.

STEM 11 TEST 2
PILOT C
LONGITUDINAL CONFIGURATION 126
LATERAL CONFIGURATION 14

Going in plane with the target won't work. Going up won't work. The only thing you can do is do a low yo-yo to pick up some speed. I'm guessing probably 20 or 30 seconds of time which is an order of magnitude higher than the other configuration. So this is really inadequate for this type of task. I am starting the nose back up around 210 knots. We've gone far enough around that I'm sort of in trail on him now. What I'm basically doing is putting him out there at about 9:30, more or less on the wing line. It feels controllable enough. It is possible that you can do a level turn and then pull up behind him. But again I think that would take a lot more time.

STEM 11 TEST 2
PILOT C
LONGITUDINAL CONFIGURATION 153
LATERAL CONFIGURATION 14

You got a lot more pitch rate (than longitudinal configuration 110/lateral configuration 11). I'm not using a lot of lateral on the task. I'm using a a quick longitudinal pull, then I'm feeding in some lateral to move the nose on around. But I don't think I'm using much lateral stick. You can certainly move the nose in pitch. I'm almost unconscious of the lateral. It's a little goosey longitudinally, but I can certainly get him inside the pipper. If anything with this configuration it's probably a little sporty at these speeds. That nose is really jumping around. I don't have a controllability problem yet, but it's pretty spectacular as fast as we're moving. You've got more than ample pitch rate. It's pretty comfortable when I'm using about 2/3 longitudinal stick to get the nose moving, and of course as your angle of attack goes on up you're going to wind up feeding the rest of it in. Now let me sort out if full stick is just too bloody much. If he was at less of an angle off, and you made that full stick

input I doubt you could stop the nose and you'd go flailing right on by him. So I think the rate is a bit excessive. By using something less than full aft stick I can do the acquisition in a comfortable period of time and not have any concerns about longitudinal overshoot. There is some pilot compensation required for this task. My roll dynamics are a little bit sluggish because I cannot make the roll correction as fast as I would like. Longitude is slightly underdamped. Lateral is soggy at high angle of attack. So if you don't have a pretty good solution laterally you're not going to get the end game. It is too fast longitudinally and not fast enough laterally at high angles of attack and harmony is probably going to be an issue, too.

STEM 11 TEST 2
PILOT C
LONGITUDINAL CONFIGURATION 110
LATERAL CONFIGURATION 11

It looks like you have to sort of baby it over there. I'm going to try slowing down and see if I can keep my energy up a little better so I can stay on the target longer. Nope, that didn't work. Now I'll see if I can get real aggressive. That works. The airplane is slow but what airplane isn't at these speeds. To acquire him, I'm keeping some roll reserve. I'm going high on him and then I'm beginning to bleed the roll down as I approach him in azimuth, but always guaranteeing that I'm going to have to make a roll correction. Because if you have to roll back up then you are in trouble. It's a little sluggish. You could use more pitch rate and roll rate but it's doable. And the time is getting on the long side to do the task.

## Summary of Design Parameters Tested for STEM 11 TEST 3

Test variables:

ZW: Indicates a variation $\zeta^*\omega$ (inverse of the pitch rate time constant). $\zeta^*\omega$ scheduled linearly with knots equivalent airspeed (KEAS) with the following value at 100 KEAS:

(-) 1.0 $sec^{-1}$, ($\tau$=1 sec)

(+) 2.0 $sec^{-1}$, ($\tau$=0.5 sec)

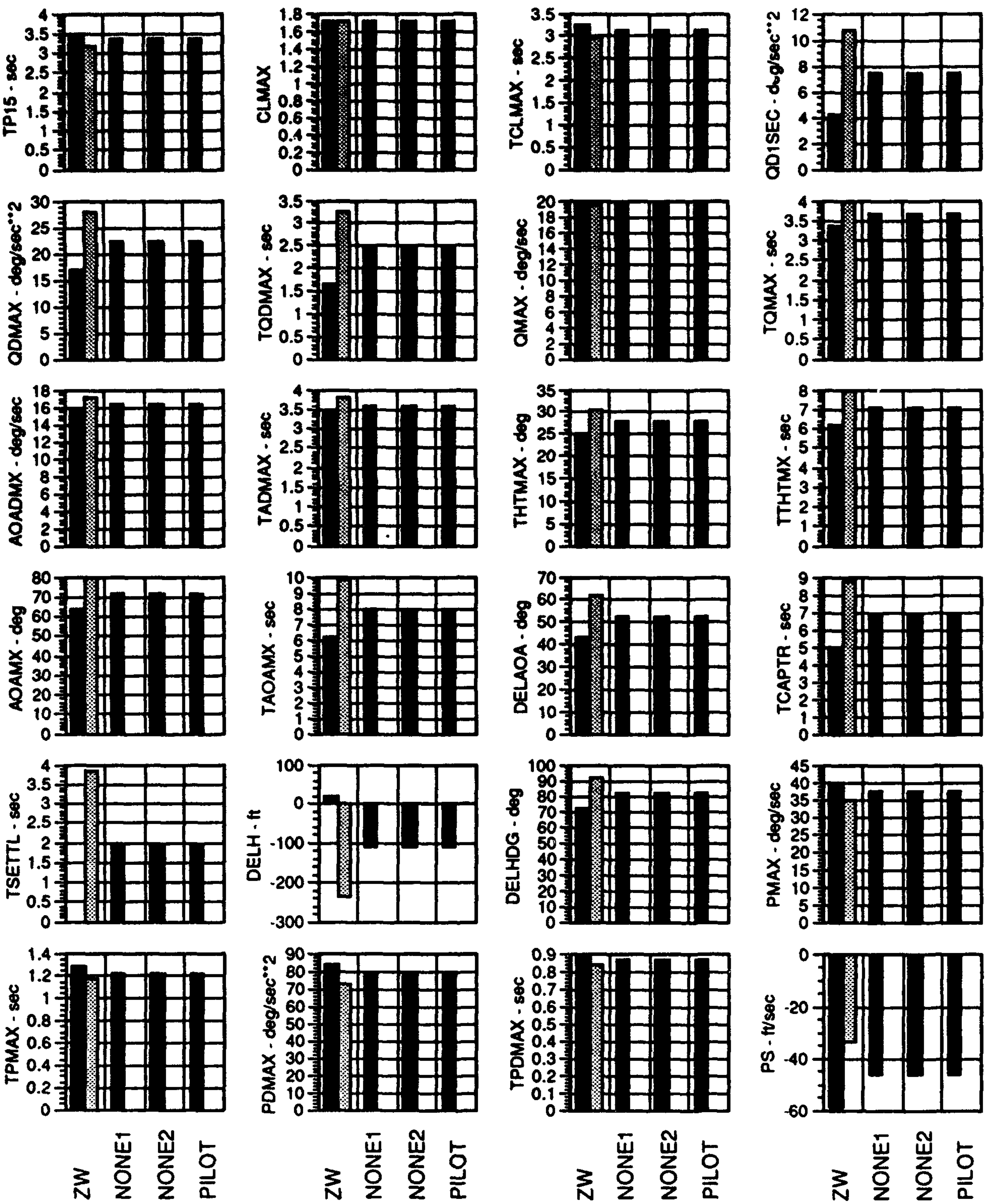
### Test Matrix

| Lon Config | Lat Config | ZW |
|---|---|---|
| 106 | 11 | 1.0 (-) |
| 155 | 11 | 2.0 (+) |

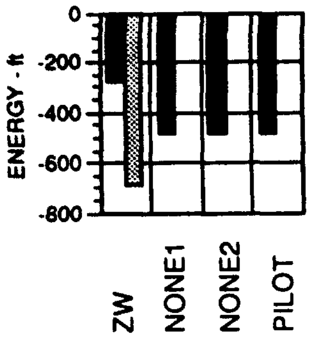
STEM 11 TEST 3

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ### | TP15 | 0.6443 | ZW | 0.644 | 3.5143 | 3.1858 | 0 | 0 | -0.098 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 3.3501 | | 0 | 0 | 0.000 | | | | |
| 2 | CLMAX | 0.8039 | ZW | 0.804 | 1.7188 | 1.7206 | 0 | 0 | 0.001 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 1.7197 | | 0 | 0 | 0.000 | | | | |
| 3 | TCLMAX | 0.7789 | ZW | 0.779 | 3.2477 | 2.9858 | 0 | 0 | -0.084 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 3.1167 | | 0 | 0 | 0.000 | | | | |
| ### | QD1SEC | 0.8075 | ZW | 0.808 | 4.1597 | 10.744 | 0 | 0 | 1.098 | #DIV/0! | 2 | ##### | ##### |
| | | | PLT | -999.000 | 7.4519 | | 0 | 0 | 0.000 | | | | |
| 6 | QDMAX | 0.8829 | ZW | 0.883 | 16.829 | 27.872 | 0 | 0 | 0.526 | #DIV/0! | 2 | ##### | ##### |
| | | | PLT | -999.000 | 22.351 | | 0 | 0 | 0.000 | | | | |
| 7 | TQDMAX | 0.6589 | ZW | 0.659 | 1.6477 | 3.2691 | 0 | 0 | 0.740 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 2.4584 | | 0 | 0 | 0.000 | | | | |
| 8 | QMAX | 0.0327 | ZW | 0.033 | 19.593 | 19.499 | 0 | 0 | -0.005 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 19.546 | | 0 | 0 | 0.000 | | | | |
| 9 | TQMAX | 0.309 | ZW | 0.309 | 3.381 | 3.9858 | 0 | 0 | 0.165 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 3.6834 | | 0 | 0 | 0.000 | | | | |
| 11 | AOADMX | 0.3546 | ZW | 0.355 | 15.668 | 17.174 | 0 | 0 | 0.092 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 16.421 | | 0 | 0 | 0.000 | | | | |
| 12 | TADMAX | 0.185 | ZW | 0.185 | 3.3977 | 3.7858 | 0 | 0 | 0.108 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 3.5917 | | 0 | 0 | 0.000 | | | | |
| 18 | THTMAX | 0.9142 | ZW | 0.914 | 25.012 | 30.6 | 0 | 0 | 0.203 | #DIV/0! | 2 | ##### | ##### |
| | | | PLT | -999.000 | 27.806 | | 0 | 0 | 0.000 | | | | |
| 19 | TTHTMX | 0.6553 | ZW | 0.655 | 6.181 | 8.0024 | 0 | 0 | 0.261 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 7.0917 | | 0 | 0 | 0.000 | | | | |
| 20 | AOAMX | 0.6769 | ZW | 0.677 | 63.813 | 79.953 | 0 | 0 | 0.227 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 71.883 | | 0 | 0 | 0.000 | | | | |
| 21 | TAOAMX | 0.6498 | ZW | 0.650 | 6.181 | 9.8191 | 0 | 0 | 0.480 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 8.0001 | | 0 | 0 | 0.000 | | | | |
| 23 | DELAOA | 0.7273 | ZW | 0.727 | 43.235 | 61.718 | 0 | 0 | 0.363 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 52.476 | | 0 | 0 | 0.000 | | | | |
| 25 | TCAPTR | 0.6692 | ZW | 0.669 | 4.9977 | 8.7358 | 0 | 0 | 0.588 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 6.8667 | | 0 | 0 | 0.000 | | | | |
| 26 | TSETTL | 0.6574 | ZW | 0.657 | 0 | 3.85 | 0 | 0 | 0.000 | #NUM! | 4 | #NUM! | #NUM! |
| | | | PLT | -999.000 | 1.925 | | 0 | 0 | 0.000 | | | | |
| ### | DELH | 0.6514 | ZW | 0.651 | 17.433 | -234.4 | 0 | 0 | -7.759 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | -108.5 | | 0 | 0 | 0.000 | | | | |
| 28 | DELHDG | 0.6788 | ZW | 0.679 | 72.187 | 91.942 | 0 | 0 | 0.244 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 82.065 | | 0 | 0 | 0.000 | | | | |
| ### | PMAX | 0.7252 | ZW | 0.725 | 40.012 | 34.612 | 0 | 0 | -0.145 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 37.312 | | 0 | 0 | 0.000 | | | | |
| 31 | TPMAX | 0.916 | ZW | 0.916 | 1.281 | 1.1691 | 0 | 0 | -0.092 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 1.2251 | | 0 | 0 | 0.000 | | | | |
| 32 | PDMAX | 0.4871 | ZW | 0.487 | 83.554 | 72.917 | 0 | 0 | -0.137 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 78.235 | | 0 | 0 | 0.000 | | | | |
| 33 | TPDMAX | 0.6036 | ZW | 0.604 | 0.8977 | 0.8358 | 0 | 0 | -0.072 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | 0.8667 | | 0 | 0 | 0.000 | | | | |
| 36 | PS | 0.7578 | ZW | 0.758 | -58.84 | -33.7 | 0 | 0 | 0.587 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | -46.27 | | 0 | 0 | 0.000 | | | | |
| 37 | ENERGY | 0.6939 | ZW | 0.694 | -278.9 | -686.3 | 0 | 0 | -1.027 | #DIV/0! | 4 | ##### | ##### |
| | | | PLT | -999.000 | -482.6 | | 0 | 0 | 0.000 | | | | |

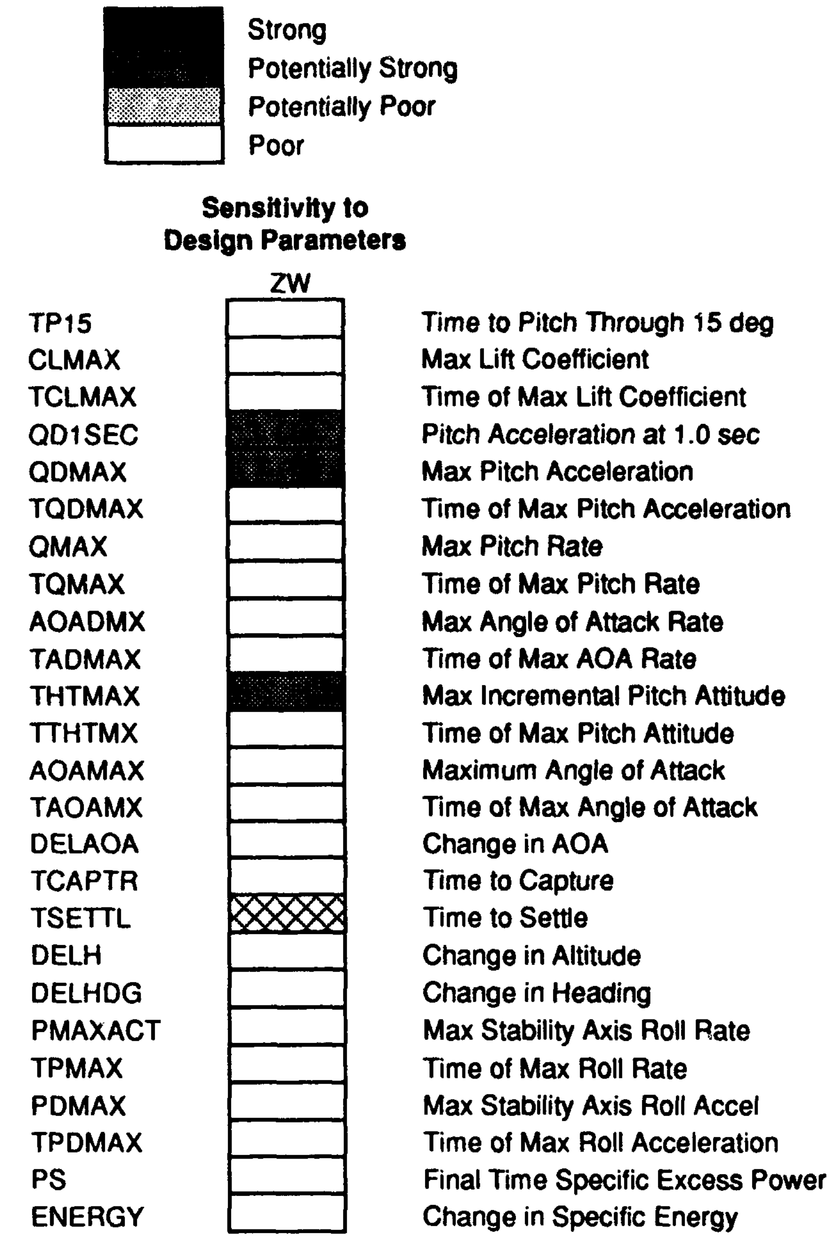
STEM 11 TEST 3



STEM 11 TEST 3



STEM 11 TEST 3




Note: Data available for only a single pilot,
therefore, sensitivity to pilot variability and overall sensitivity not shown.

STEM 11 TEST 3
PILOT C
LONGITUDINAL CONFIGURATION 106
LATERAL CONFIGURATION 11

It is hard to remember that you have to go all the way back to zero longitudinal stick to stop. But once you have him there, you can hold him there as long as you wish. I was having more trouble laterally than I was longitudinally. I think with a little practice you could get that one to go pretty quick. That's actually quite doable. The hardest part is remembering you've got to go all the way back to neutral stick. Of course any big lateral input when you are tracking the target and you become disoriented because we are seeing alphas around 100 degrees. Piece of cake. After one or two runs, it becomes very natural and very easy to control.

STEM 11 TEST 3
PILOT C
LONGITUDINAL CONFIGURATION 155
LATERAL CONFIGURATION 11

This one is easy to over control. PIO prone. Whatever you did to that, it is extremely PIO prone. You've got to entirely get out of the loop and sneak up on him again. Very easy to get out of phase with that. Even trying to do a simulated tracking task it is very easy to get out of phase with that.

## Summary of Design Parameters Tested for STEM 11 TEST 4

Test variables:

LONDYN: Variations in a combination of longitudinal dynamics were implemented. The variations were expected to cover a range of poor and good dynamics:

(-) Poor, (CAP=0.6; ZSP=0.35 for low AOA, ZSP=0.6 for high AOA, no longitudinal stick shaping)

(+) Good, (CAP=0.6; ZSP=0.7 for low AOA, ZSP=1.2 for high AOA, with longitudinal stick shaping)

AOAMAX: Indicates a maximum AOA or load factor depending on flight condition. This also indicates a variation in stick sensitivity:

For low speed (<Vc), maximum AOA set at:

(-) 40°, Aircraft can reach maximum lift but cannot reach post-stall

(+) 60°, Aircraft can be flown post-stall

For high speed (≥Vc), maximum load factor set at:

(-) 7g

(+) 9g

LATDYN: Variations in a combination of lateral dynamics were implemented. The variations were expected to cover a range of poor and good dynamics:

(-) poor, a schedule of TR and PMAX with AOA was implemented based on MIL-STD-1797A and MCAIR high AOA research.

| AOA | TR | PMAX |
|---|---|---|
| 5° | 0.6 sec | 150.0 deg/sec |
| 15° | 1.0 sec | 100.0 deg/sec |
| 30° | 1.8 sec | 40.0 deg/sec |
| 60° | 2.1 sec | 10.0 deg/sec |

(+) good, a schedule of TR and PMAX with AOA was implemented based on MIL-STD-1797A and MCAIR high AOA research.

| AOA | TR | PMAX |
|---|---|---|
| 5° | 0.4 sec | 180.0 deg/sec |
| 15° | 0.6 sec | 150.0 deg/sec |
| 30° | 1.0 sec | 90.0 deg/sec |
| 60° | 1.6 sec | 70.0 deg/sec |

RANGE: Indicates the two initial down ranges tested.

(-) 1.3 nm, Nominal down range tested.

(+) 0.9 nm, Minimum range tested.

### Range Test Matrix (Pilots A,F - Only Pilot A for range variation)

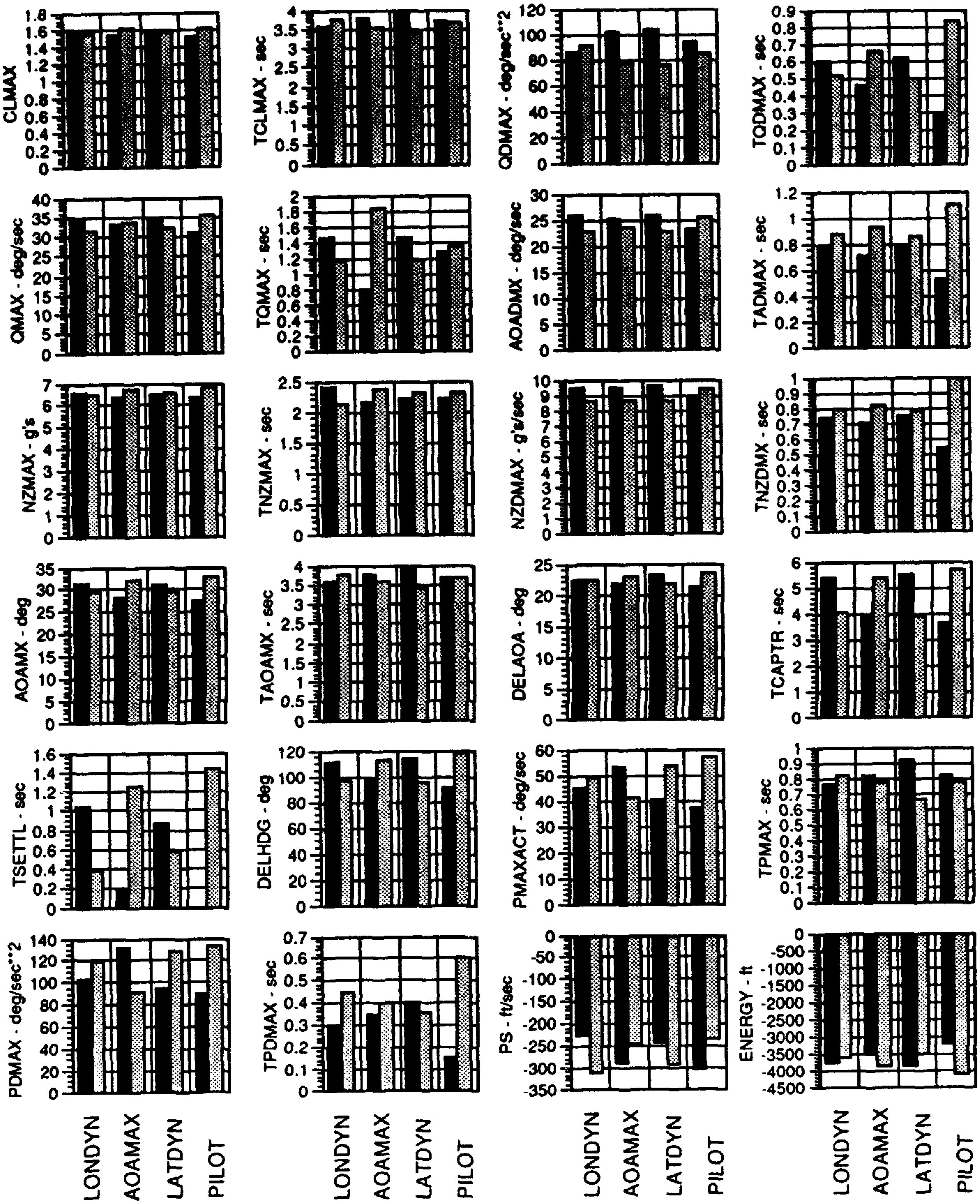
| Lon Config | Lat Config | LONDYN | AOAMAX | LATDYN | RANGE |
|---|---|---|---|---|---|
| 101 | 11 | Poor (-) | 7g/40° (-) | Good (+) | (-) Nominal |
| 126 | 20 | Good (+) | 7g/40° (-) | Poor (-) | (-) Nominal |
| 119 | 20 | Poor (-) | 9g/60° (+) | Poor (-) | (-) Nominal |
| 120 | 11 | Good (+) | 9g/60° (+) | Good (+) | (-) Nominal |
| 120 | 11 | Good (+) | 9g/60° (+) | Good (+) | (+) Minimum |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | CLMAX | 0.9999 | LONDYN | 0.960 | 1.5825 | 1.5563 | 0 | 0 | -0.017 | 0.25 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 1.5349 | 1.6039 | 0 | 0 | 0.044 | 0.66 | 4 | 3 | 4 |
| | | | LATDYN | 0.678 | 1.5754 | 1.5634 | 0 | 0 | -0.008 | 0.11 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 1.5171 | 1.6217 | 0 | 0 | 0.067 | | | | |
| 3 | TCLMAX | 0.9999 | LONDYN | 0.747 | 3.5842 | 3.7705 | 0 | 0 | 0.051 | 4.28 | 4 | 1 | 4 |
| | | | AOAMAX | 0.855 | 3.7978 | 3.5569 | 0 | 0 | -0.066 | 5.54 | 4 | 1 | 4 |
| | | | LATDYN | 0.996 | 3.9407 | 3.414 | 0 | 0 | -0.144 | 12.17 | 3 | 1 | 3 |
| | | | PLT | 0.215 | 3.6991 | 3.6556 | 0 | 0 | -0.012 | | | | |
| 6 | QDMAX | 0.9987 | LONDYN | 0.411 | 86.773 | 91.609 | 0 | 0 | 0.054 | 0.52 | 4 | 3 | 4 |
| | | | AOAMAX | 0.987 | 101.51 | 76.874 | 0 | 0 | -0.282 | 2.69 | 2 | 1 | 2 |
| | | | LATDYN | 0.994 | 103.05 | 75.331 | 0 | 0 | -0.318 | 3.05 | 2 | 1 | 2 |
| | | | PLT | 0.695 | 93.841 | 84.541 | 0 | 0 | -0.105 | | | | |
| 7 | TQDMAX | 0.9846 | LONDYN | 0.436 | 0.5925 | 0.5163 | 0 | 0 | -0.138 | 0.10 | 4 | 3 | 4 |
| | | | AOAMAX | 0.868 | 0.452 | 0.6569 | 0 | 0 | 0.383 | 0.28 | 3 | 3 | 4 |
| | | | LATDYN | 0.610 | 0.6115 | 0.4974 | 0 | 0 | -0.208 | 0.15 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 0.2741 | 0.8348 | 0 | 0 | 1.359 | | | | |
| 8 | QMAX | 0.9991 | LONDYN | 0.962 | 35.166 | 31.398 | 0 | 0 | -0.114 | 0.82 | 3 | 3 | 4 |
| | | | AOAMAX | 0.301 | 32.953 | 33.612 | 0 | 0 | 0.020 | 0.14 | 4 | 3 | 4 |
| | | | LATDYN | 0.824 | 34.464 | 32.1 | 0 | 0 | -0.071 | 0.51 | 4 | 3 | 4 |
| | | | PLT | 0.986 | 30.981 | 35.584 | 0 | 0 | 0.139 | | | | |
| 9 | TQMAX | 0.879 | LONDYN | 0.543 | 1.455 | 1.1788 | 0 | 0 | -0.212 | 3.61 | 4 | 1 | 4 |
| | | | AOAMAX | 0.989 | 0.7936 | 1.8402 | 0 | 0 | 0.944 | 16.06 | 1 | 1 | 1 |
| | | | LATDYN | 0.550 | 1.4573 | 1.1765 | 0 | 0 | -0.216 | 3.67 | 4 | 1 | 4 |
| | | | PLT | 0.166 | 1.2783 | 1.3556 | 0 | 0 | 0.059 | | | | |
| 11 | AOADMX | 0.9896 | LONDYN | 0.875 | 25.821 | 22.804 | 0 | 0 | -0.125 | 1.40 | 4 | 2 | 4 |
| | | | AOAMAX | 0.600 | 25.118 | 23.507 | 0 | 0 | -0.066 | 0.75 | 4 | 3 | 4 |
| | | | LATDYN | 0.883 | 25.858 | 22.767 | 0 | 0 | -0.128 | 1.44 | 4 | 2 | 4 |
| | | | PLT | 0.736 | 23.234 | 25.391 | 0 | 0 | 0.089 | | | | |
| 12 | TADMAX | 0.9997 | LONDYN | 0.738 | 0.7675 | 0.8705 | 0 | 0 | 0.126 | 0.16 | 4 | 3 | 4 |
| | | | AOAMAX | 0.969 | 0.7145 | 0.9236 | 0 | 0 | 0.260 | 0.33 | 2 | 3 | 4 |
| | | | LATDYN | 0.676 | 0.774 | 0.864 | 0 | 0 | 0.110 | 0.14 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 0.5324 | 1.1056 | 0 | 0 | 0.797 | | | | |
| 14 | NZMAX | 0.9999 | LONDYN | 0.826 | 6.5984 | 6.5323 | 0 | 0 | -0.010 | 0.14 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 6.3872 | 6.7434 | 0 | 0 | 0.054 | 0.74 | 4 | 3 | 4 |
| | | | LATDYN | 0.946 | 6.517 | 6.6136 | 0 | 0 | 0.015 | 0.20 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 6.326 | 6.8046 | 0 | 0 | 0.073 | | | | |
| 15 | TNZMAX | 0.8447 | LONDYN | 0.688 | 2.3967 | 2.133 | 0 | 0 | -0.117 | 2.01 | 4 | 1 | 4 |
| | | | AOAMAX | 0.598 | 2.1561 | 2.3736 | 0 | 0 | 0.096 | 1.66 | 4 | 2 | 4 |
| | | | LATDYN | 0.322 | 2.2115 | 2.3182 | 0 | 0 | 0.047 | 0.81 | 4 | 3 | 4 |
| | | | PLT | 0.390 | 2.1991 | 2.3306 | 0 | 0 | 0.058 | | | | |
| 16 | NZDMAX | 0.9792 | LONDYN | 0.787 | 9.5309 | 8.6718 | 0 | 0 | -0.095 | 1.67 | 4 | 2 | 4 |
| | | | AOAMAX | 0.810 | 9.5541 | 8.6486 | 0 | 0 | -0.100 | 1.76 | 4 | 2 | 4 |
| | | | LATDYN | 0.869 | 9.6286 | 8.5741 | 0 | 0 | -0.116 | 2.05 | 4 | 1 | 4 |
| | | | PLT | 0.552 | 8.844 | 9.3587 | 0 | 0 | 0.057 | | | | |
| 17 | TNZDMX | 0.9988 | LONDYN | 0.517 | 0.7384 | 0.7913 | 0 | 0 | 0.069 | 0.11 | 4 | 3 | 4 |
| | | | AOAMAX | 0.842 | 0.7103 | 0.8194 | 0 | 0 | 0.143 | 0.22 | 4 | 3 | 4 |
| | | | LATDYN | 0.327 | 0.749 | 0.7807 | 0 | 0 | 0.041 | 0.06 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 0.5366 | 0.9931 | 0 | 0 | 0.655 | | | | |
| 20 | AOAMX | 0.9999 | LONDYN | 0.988 | 31.177 | 29.264 | 0 | 0 | -0.063 | 0.34 | 4 | 3 | 4 |
| | | | AOAMAX | 1.000 | 28.238 | 32.203 | 0 | 0 | 0.132 | 0.71 | 3 | 3 | 4 |
| | | | LATDYN | 0.948 | 30.936 | 29.506 | 0 | 0 | -0.047 | 0.25 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 27.438 | 33.003 | 0 | 0 | 0.186 | | | | |
| 21 | TAOAMX | 0.9999 | LONDYN | 0.712 | 3.5884 | 3.7622 | 0 | 0 | 0.047 | 12.13 | 4 | 1 | 4 |
| | | | AOAMAX | 0.800 | 3.7811 | 3.5694 | 0 | 0 | -0.058 | 14.78 | 4 | 1 | 4 |
| | | | LATDYN | 0.996 | 3.9448 | 3.4057 | 0 | 0 | -0.147 | 37.80 | 3 | 1 | 3 |
| | | | PLT | 0.071 | 3.6824 | 3.6681 | 0 | 0 | -0.004 | | | | |

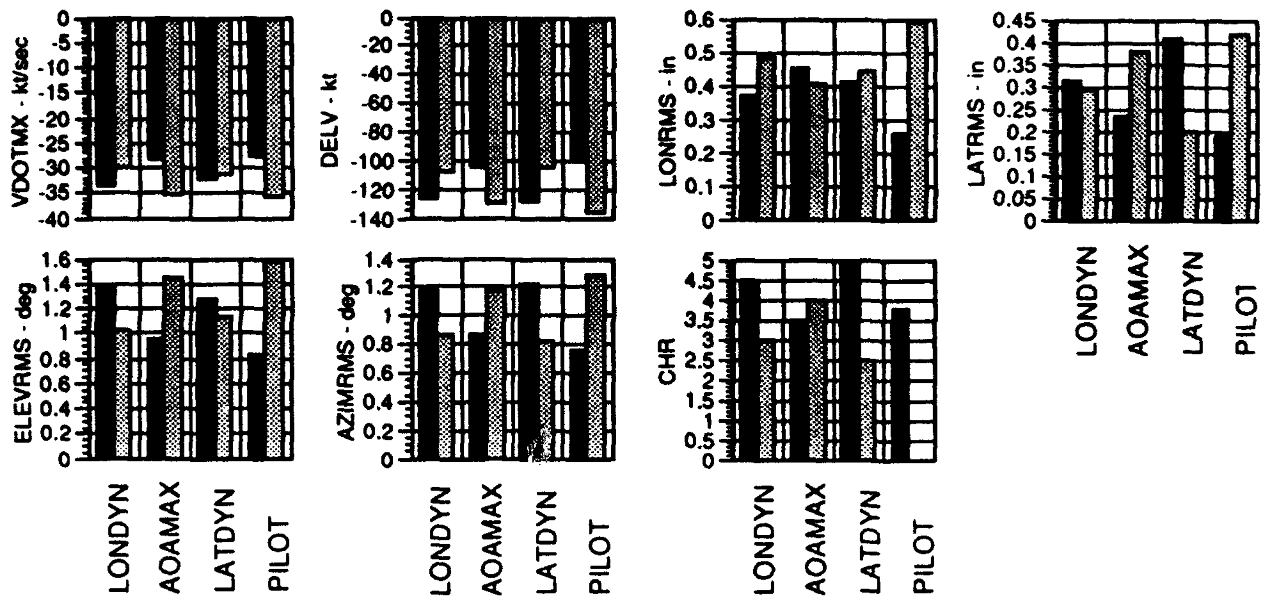
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23 | DELAOA | 0.9763 | LONDYN | 0.053 | 22.377 | 22.429 | 0 | 0 | 0.002 | 0.02 | 4 | 3 | 4 |
| | | | AOAMAX | 0.862 | 21.806 | 22.999 | 0 | 0 | 0.053 | 0.49 | 4 | 3 | 4 |
| | | | LATDYN | 0.912 | 23.098 | 21.708 | 0 | 0 | -0.062 | 0.57 | 4 | 3 | 4 |
| | | | PLT | 0.994 | 21.197 | 23.609 | 0 | 0 | 0.108 | | | | |
| 25 | TCAPTR | 0.9999 | LONDYN | 0.998 | 5.3634 | 4.033 | 0 | 0 | -0.289 | 0.63 | 2 | 3 | 4 |
| | | | AOAMAX | 0.999 | 3.9978 | 5.3986 | 0 | 0 | 0.305 | 0.66 | 2 | 3 | 4 |
| | | | LATDYN | 1.000 | 5.4782 | 3.9182 | 0 | 0 | -0.341 | 0.74 | 2 | 3 | 4 |
| | | | PLT | 1.000 | 3.6699 | 5.7264 | 0 | 0 | 0.460 | | | | |
| 26 | TSETTL | 0.8383 | LONDYN | 0.668 | 1.05 | 0.3917 | 0 | 0 | -1.154 | | 4 | | 4 |
| | | | AOAMAX | 0.875 | 0.1875 | 1.2542 | 0 | 0 | 3.270 | | 2 | | 2 |
| | | | LATDYN | 0.328 | 0.8625 | 0.5792 | 0 | 0 | -0.409 | | 4 | | 4 |
| | | | PLT | 0.956 | 0 | 1.4417 | 0 | 0 | 0.000 | | | | |
| 28 | DELHDG | 0.9999 | LONDYN | 0.988 | 111.57 | 97.433 | 0 | 0 | -0.136 | 0.53 | 3 | 3 | 4 |
| | | | AOAMAX | 0.995 | 96.52 | 112.48 | 0 | 0 | 0.154 | 0.60 | 3 | 3 | 4 |
| | | | LATDYN | 0.998 | 113.85 | 95.151 | 0 | 0 | -0.180 | 0.70 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 91.32 | 117.68 | 0 | 0 | 0.256 | | | | |
| 30 | PMAXACT | 0.9999 | LONDYN | 0.742 | 44.977 | 49.02 | 0 | 0 | 0.086 | 0.20 | 4 | 3 | 4 |
| | | | AOAMAX | 0.997 | 53.092 | 40.905 | 0 | 0 | -0.264 | 0.61 | 2 | 3 | 4 |
| | | | LATDYN | 0.999 | 40.093 | 53.904 | 0 | 0 | 0.300 | 0.69 | 2 | 3 | 4 |
| | | | PLT | 1.000 | 37.231 | 56.766 | 0 | 0 | 0.434 | | | | |
| 31 | TPMAX | 0.9692 | LONDYN | 0.607 | 0.7634 | 0.8205 | 0 | 0 | 0.072 | 1.20 | 4 | 2 | 4 |
| | | | AOAMAX | 0.502 | 0.8145 | 0.7694 | 0 | 0 | -0.057 | 0.95 | 4 | 3 | 4 |
| | | | LATDYN | 0.999 | 0.9198 | 0.664 | 0 | 0 | -0.332 | 5.50 | 2 | 1 | 2 |
| | | | PLT | 0.526 | 0.8158 | 0.7681 | 0 | 0 | -0.060 | | | | |
| 32 | PDMAX | 0.9988 | LONDYN | 0.778 | 103.11 | 118.72 | 0 | 0 | 0.141 | 0.35 | 4 | 3 | 4 |
| | | | AOAMAX | 0.995 | 130.96 | 90.872 | 0 | 0 | -0.374 | 0.93 | 2 | 3 | 4 |
| | | | LATDYN | 0.988 | 93.606 | 128.22 | 0 | 0 | 0.320 | 0.79 | 2 | 3 | 4 |
| | | | PLT | 0.997 | 89.407 | 132.42 | 0 | 0 | 0.403 | | | | |
| 33 | TPDMAX | 0.9989 | LONDYN | 0.920 | 0.3009 | 0.4497 | 0 | 0 | 0.413 | 0.22 | 1 | 3 | 3 |
| | | | AOAMAX | 0.499 | 0.3478 | 0.4027 | 0 | 0 | 0.147 | 0.08 | 4 | 3 | 4 |
| | | | LATDYN | 0.440 | 0.399 | 0.3515 | 0 | 0 | -0.127 | 0.07 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 0.1491 | 0.6014 | 0 | 0 | 1.893 | | | | |
| 36 | PS | 0.9993 | LONDYN | 0.987 | -226.23 | -311.75 | 0 | 0 | -0.326 | 1.24 | 2 | 2 | 3 |
| | | | AOAMAX | 0.812 | -290.13 | -247.85 | 0 | 0 | 0.158 | 0.60 | 4 | 3 | 4 |
| | | | LATDYN | 0.886 | -243.27 | -294.71 | 0 | 0 | -0.193 | 0.74 | 4 | 3 | 4 |
| | | | PLT | 0.962 | -30[illegible].66 | -234.32 | 0 | 0 | 0.262 | | | | |
| 37 | ENERGY | 0.9999 | LONDYN | 0.859 | -3750.1 | -3597.4 | 0 | 0 | 0.042 | 0.16 | 4 | 3 | 4 |
| | | | AOAMAX | 0.999 | -3463.5 | -3884.1 | 0 | 0 | -0.115 | 0.45 | 3 | 3 | 4 |
| | | | LATDYN | 0.998 | -3850.7 | -3496.8 | 0 | 0 | 0.097 | 0.38 | 4 | 3 | 4 |
| | | | PLT | 1.000 | -3211.5 | -4136 | 0 | 0 | -0.256 | | | | |
| 38 | VDOTMX | 0.9999 | LONDYN | 0.977 | -33.432 | -30.059 | 0 | 0 | 0.107 | 0.42 | 3 | 3 | 4 |
| | | | AOAMAX | 1.000 | -28.081 | -35.411 | 0 | 0 | -0.234 | 0.93 | 2 | 3 | 4 |
| | | | LATDYN | 0.459 | -32.166 | -31.325 | 0 | 0 | 0.026 | 0.11 | 4 | 3 | 4 |
| | | | PLT | 1.000 | -27.825 | -35.667 | 0 | 0 | -0.251 | | | | |
| 39 | DELV | 0.9999 | LONDYN | 0.997 | -126.53 | -107.47 | 0 | 0 | 0.164 | 0.50 | 3 | 3 | 4 |
| | | | AOAMAX | 1.000 | -104.54 | -129.45 | 0 | 0 | -0.215 | 0.66 | 2 | 3 | 4 |
| | | | LATDYN | 1.000 | -128.83 | -105.16 | 0 | 0 | 0.204 | 0.62 | 2 | 3 | 4 |
| | | | PLT | 1.000 | -98.292 | -135.7 | 0 | 0 | -0.328 | | | | |
| 42 | LONRMS | 0.9999 | LONDYN | 0.980 | 0.3675 | 0.4825 | 0 | 0 | 0.276 | 0.29 | 2 | 3 | 4 |
| | | | AOAMAX | 0.683 | 0.4481 | 0.4019 | 0 | 0 | -0.109 | 0.12 | 4 | 3 | 4 |
| | | | LATDYN | 0.516 | 0.409 | 0.4411 | 0 | 0 | 0.076 | 0.08 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 0.2559 | 0.5941 | 0 | 0 | 0.945 | | | | |
| 43 | LATRMS | 0.985 | LONDYN | 0.183 | 0.3128 | 0.2946 | 0 | 0 | -0.060 | 0.07 | 4 | 3 | 4 |
| | | | AOAMAX | 0.920 | 0.2311 | 0.3762 | 0 | 0 | 0.507 | 0.58 | 1 | 3 | 3 |
| | | | LATDYN | 0.983 | 0.4069 | 0.2005 | 0 | 0 | -0.768 | 0.87 | 1 | 3 | 3 |
| | | | PLT | 0.991 | 0.1891 | 0.4183 | 0 | 0 | 0.880 | | | | |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 44 | ELEVRMS | 0.99 | LONDYN | 0.894 | 1.3847 | 1.0177 | 0 | 0 | -0.313 | 0.45 | 3 | 3 | 4 |
| | | | AOAMAX | 0.965 | 0.9549 | 1.4475 | 0 | 0 | 0.428 | 0.62 | 1 | 3 | 3 |
| | | | LATDYN | 0.473 | 1.2704 | 1.132 | 0 | 0 | -0.116 | 0.17 | 4 | 3 | 4 |
| | | | PLT | 0.997 | 0.8257 | 1.5767 | 0 | 0 | 0.693 | | | | |
| 45 | AZIMRMS | 0.9827 | LONDYN | 0.816 | 1.1744 | 0.8623 | 0 | 0 | -0.314 | 0.57 | 3 | 3 | 4 |
| | | | AOAMAX | 0.809 | 0.8648 | 1.1719 | 0 | 0 | 0.309 | 0.56 | 3 | 3 | 4 |
| | | | LATDYN | 0.909 | 1.2206 | 0.8161 | 0 | 0 | -0.413 | 0.75 | 1 | 3 | 3 |
| | | | PLT | 0.968 | 0.7548 | 1.2819 | 0 | 0 | 0.555 | | | | |
| 49 | CHR | 0 | LONDYN | -999.000 | 4.5 | 3 | 0 | 0 | -0.417 | 0.00 | 4 | 3 | 4 |
| | | | AOAMAX | -999.000 | 3.5 | 4 | 0 | 0 | 0.134 | 0.00 | 4 | 3 | 4 |
| | | | LATDYN | -999.000 | 5 | 2.5 | 0 | 0 | -0.750 | 0.01 | 4 | 3 | 4 |
| | | | PLT | -999.000 | 3.75 | -999 | 0 | 0 | -134.202 | | | | |

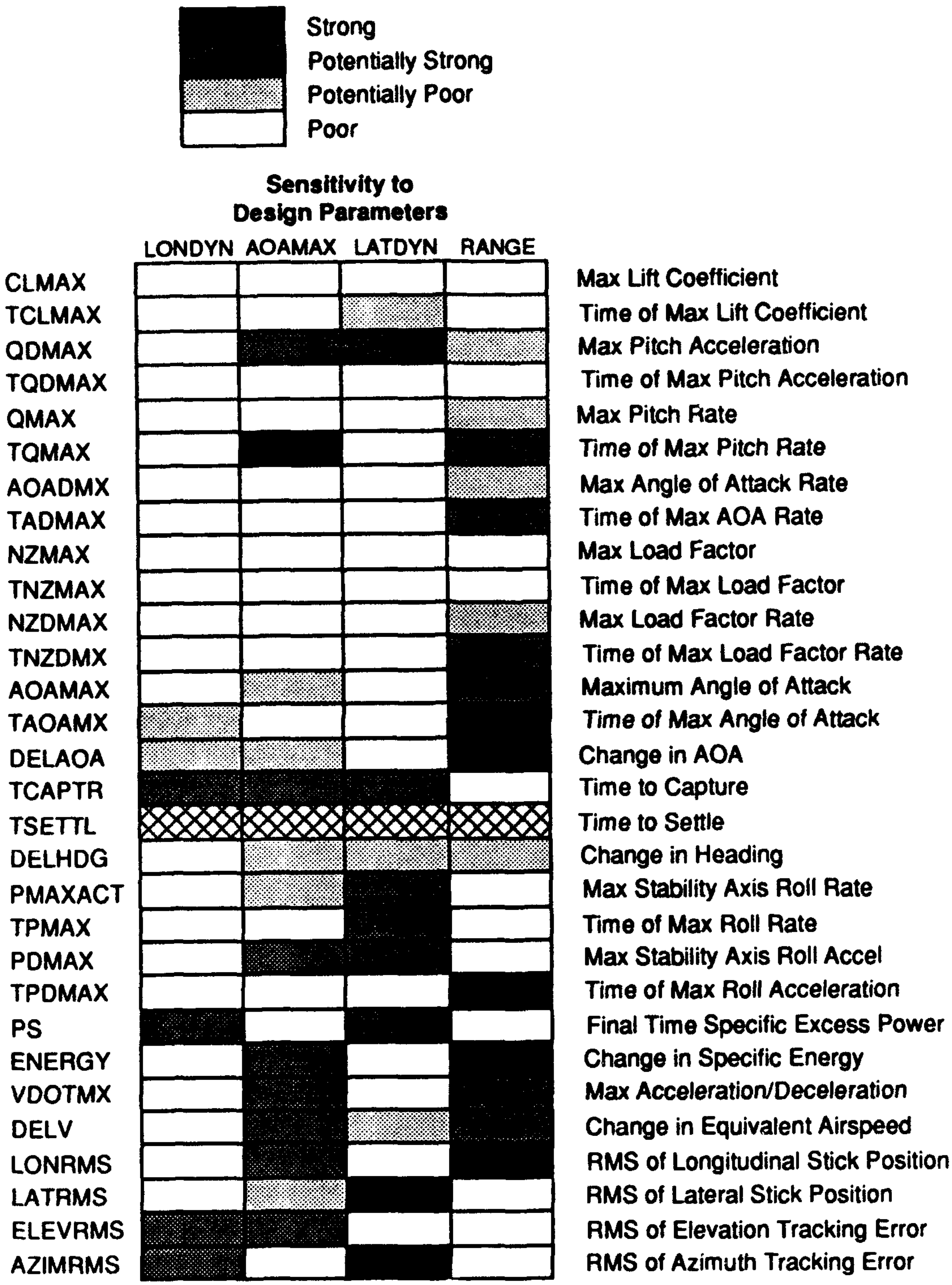
STEM 11 TEST 4



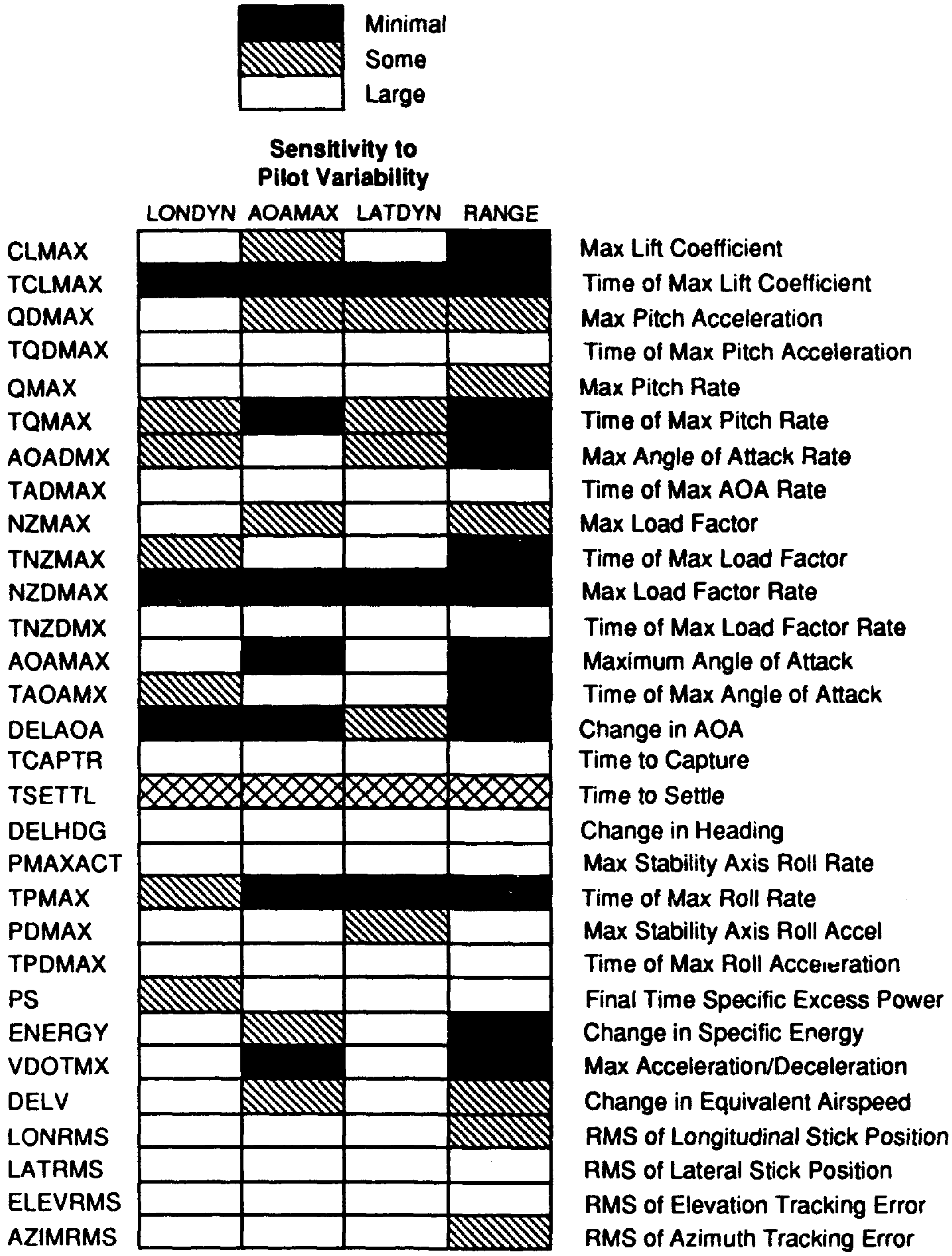
## STEM 11 TEST 4



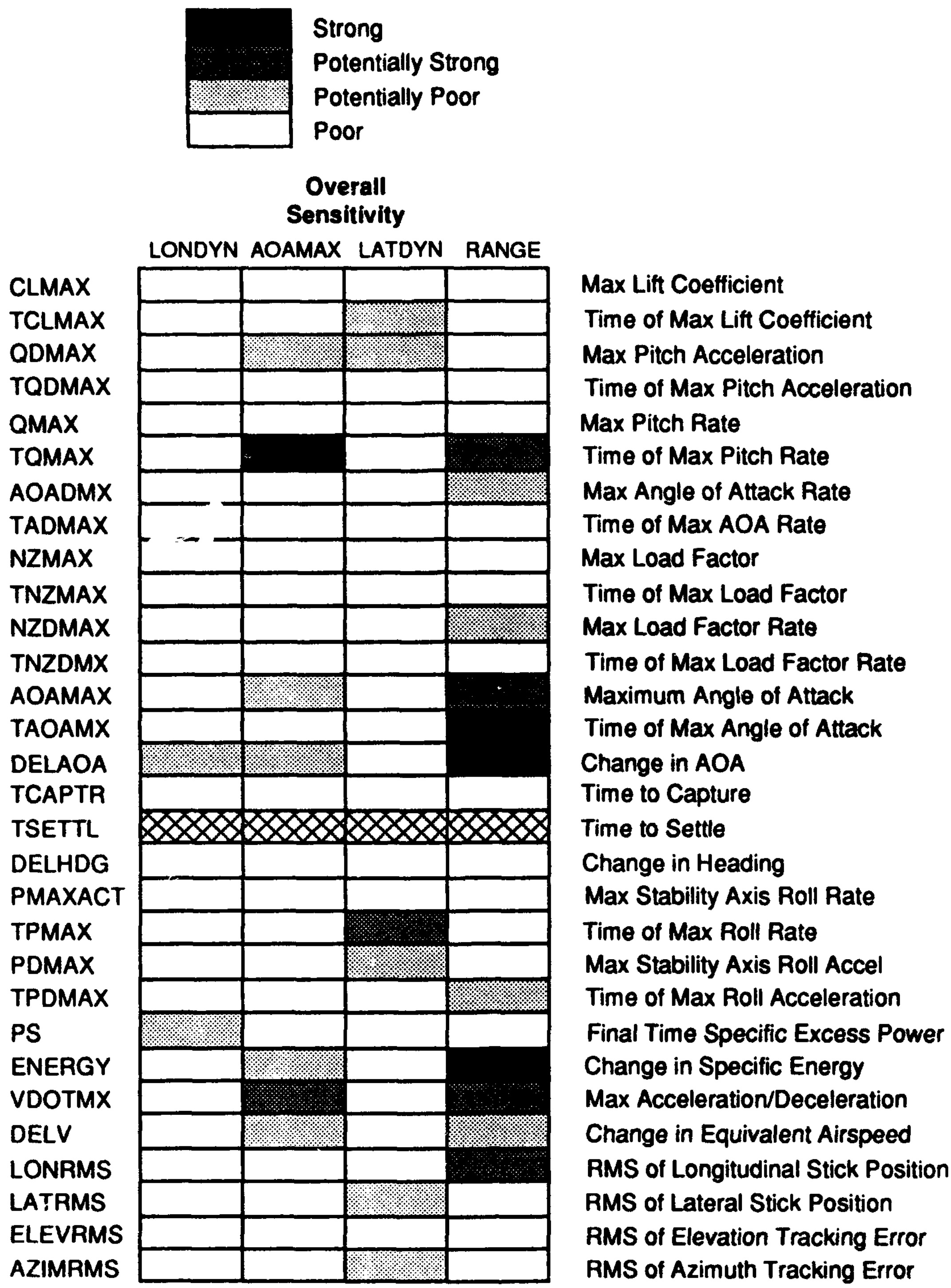
STEM 11 TEST 4



STEM 11 TEST 4



## STEM 11 TEST 4



STEM 11 TEST 4
PILOT A
LONGITUDINAL CONFIGURATION 126
LATERAL CONFIGURATION 20
CHR 4
PIO 2

In this one we're pitch rate limited. I'm sitting on the aft stop waiting. That gives me time to solve my lateral-directional problems. That run I exagerated it and held full aft stick until a little bit too late and so I ended up with lateral PIO. I can't be quite that demanding on the pitch rate otherwise I can't settle down the yaw when I get there. It turns into a three dimensional problem when I get there. If I just back off the pitch rate a little here, then we get a beautiful solution. My initial limitation is the pitch rate but if I hold the maximum pitch rate in a little bit too long then I'm hampered by the lateral predictability. So I need to hold in full pitch rate until I'm just about there and then slowly ease off on the pitch rate so that I can get the lateral problem sorted out into the terminal track. Was it controllable? Yes. Adequate, yes. I could get there within desired performance. I was happy with the amount of time it took to get there. It was pitch rate limited at the beginning so it was a little slower than I would have liked but it's still a desirable amount of time. Much slower than that and it would be getting very close to the border between adequate and desirable as far as the amount of time. If I shape it properly, if I go to full aft stick and then when I'm getting within about 10 degrees of the target slowly ease off my pitch input to a slow pitch capture, then I don't end up with much lateral problem and I can get there. It takes a reasonable amount of pilot compensation to make it happen so it's somewhere between a CHR 3 and a 4 again. I have to call it moderate compensation because if I do make a mistake, if I get there a little too soon then I end up with a lateral problem that takes a long time to solve and it's almost putting me to adequate criteria. So I do have to pay attention, I have to feed the stick just right, it's minor but it's annoying. PIO rating - there is a lateral tendency. The technique I'm talking about where I use a fade off of the longitudinal input will prevent or eliminate the lateral PIOs. It doesn't take a lot of effort, it just has to be a different technique.

STEM 11 TEST 4
PILOT F
LONGITUDINAL CONFIGURATION 126
LATERAL CONFIGURATION 20

What I'm finding out is that the speed that I'm flying when I roll into it I feel very sluggish in pitch onset because I'm obviously fast. Heavy stick forces because I'm not trim and I pull the nose and the pitch rate isn't all that impressive but then again I'm in a conventional envelope. When I get up there I'm having a little bit of a tracking problem. Not much of one, a little bit again the lateral but not nearly what it was before. I mean its not really even comparable to the stuff we did previous. And I'm not of a high enough angle of attack to be arcing. This platform just seems a little sluggish in the pitch. Let me try trimming on this one just to see if there's a difference. Trim doesn't seem to make a whole lot of difference on that. The only comments I have on the configuration we just ran is it seems a bit sluggish in pitch. Seems like the stick forces are high which and it didn't really respond that well to some pretty aggressive pulls on the stick. And then you know, tracking

wasn't all that difficult although the only problem I did have was a slight roll adjustment once I got targeted in the acquisition.

STEM 11 TEST 4
PILOT A
LONGITUDINAL CONFIGURATION 101
LATERAL CONFIGURATION 11
CHR 3
PIO 2

The technique I'm using is initially apply a little bit of aft stick to get the nose started and then roll to get him on my lift vector. And then pull to try and smoothly capture him because I find the pitch response to be more predictable than the lateral response. Especially since my angle of attack is changing constantly. I'm not using full aft stick because that just bounces me so fast that I end up getting there too soon and end up in a longitudinal PIO.
When I'm getting towards the capture I have to be very careful directionally because if it gets a little bit off it takes a smooth, positive correction to get them back in without causing a lateral PIO. And the capture is happening fairly fast so I can't go rushing into it, otherwise I bounce around and it takes quite a while to settle down in a tracking solution. But if I do it smoothly and compensate some then I can smoothly bring my nose up. The time it takes to get him is good, it comes up quickly, and that's a desirable amount of time. Is it controllable? Yes. Is adequate performance attainable? Yes. Satisfactory without improvement? I would say yes. It requires some pilot compensation; there's some mildy unpleasant deficiencies. I wish it wasn't so ratchety in roll. But if I just fly a smooth airplane and get there in a reasonable amount of time, the airplane does okay. There is a tendency for PIO. These motions can be prevented or eliminated by pilot technique. So long as I work as a low gain input then the PIOs don't become a problem. But when I drive it to high gain then it will possibly. And to improve that it would be to improve the harmony again, give me a little more predictable lateral control so that I could get a combined slashing kind of capture on him rather than try to sort out my lateral-directional problems and then capture him purely in pitch. If I had more confidence in my lateral predictability then I could come in at him from more like a 2 o'clock position.

STEM 11 TEST 4
PILOT F
LONGITUDINAL CONFIGURATION 101
LATERAL CONFIGURATION 11

My first impressions on the flight control system is that it is very sensitive in pitch. Now, I am trying to be a little bit slower with the input and lead it a little bit. When I back off the stick the pitch rate slows down and I don't have any trouble stabilizing on the target and I'm getting a little bit of a pitch PIO. It appears that the pitch system is a little bit sensitive to power inputs. And it also seems like the pitch system is not only sensitive to stick input, there's a slight lag before it takes effect which makes it doubly difficult to do precise tracking unless you lead the stop point in pitch. Because the systems is so goosey in pitch, as I get a good onset rate then I start backing it off to make sure I've got the rate stabilized as I approach the target and then slow it down

as it approaches the target. Basically it's a straight line from roll in. Rapid pitch acceleration, slight let off of the stick to slow the acceleration to the point where I can control it to the track. In the previous runs I just held the stick aft longer and I'd get a pitch overshoot then try to adjust it once the pipper was there which put me in a PIO. Essentially I think there's a lag in the pitch control system here and also its sensitive to stick inputs which do affect it.

STEM 11 TEST 4
PILOT A
LONGITUDINAL CONFIGURATION 119
LATERAL CONFIGURATION 20
CHR 6
PIO 4

I put in full aft stick and for a moment there I could see the back of my head. Gads. Okay, let's become a big rate limiter of my own here and see if I can solve it. This is not an easy airplane to do this with. Geez, I don't like this, I mean it's all power and no brains with this configuration. Sometimes I can make desired criteria but not with the tolerable workload. I mean, that's everything I can do to get it in there and then it's bouncing the full plus or minus 40 of the circle. A tremendous pitch power available but very poor mechanization of it. I wonder if there's some other way to use this. I'm just going to play with this a little longer because I'm using it like a conventional airplane and I don't like it. Let's try it a different way. Let's get in the neighborhood with it, now settle down and it's not predictable enough laterally to do that. No that's not the way to do it. Okay let's try a lead turn, settle it in. Nope. That's just as bad. That's as best as I can do like that where I'm getting no where near the pitch performance out of the airplane it's capable of. I'm being such a low gain input to keep the thing from oscillating all over. And that's slowing down my rates enough that I don't end up in the horrible lateral PIO it wants to get me into. So I'm putting very minimal demands on a very powerful and undisciplined system here. If I try and capture any faster it takes longer because I just can't settle it down in the end game because the harmony is so bad and the responses are so quick and unpredictable. Is it controllable? Yes. Adequate performance attainable with a tolerable workload? Yes. Satisfactory without improvement? No. It was taking just about everything I could do to make desired performance which is not moderate compensation. I really did not like it, I had a tremendous amount of capability, both in pitch and laterally, but the mechanization of the control of them was very poor so that I could get no where near to using the performance limit of the airplane. So what I ended up doing was flying it like a much less capable airplane in order to keep from getting into those areas of bad handling qualities. So it was tolerable in that I could make my adequate criteria, but just barely. It requires extensive pilot compensation; you have to do it just right otherwise you don't get there. PIO rating, there's definitely a tendency. I had to reduce my gains way down in order to keep from PIOing the thing off the target and getting no solution. The time to get there was okay, I could still get there in about 100 degrees of turn, but with the capability of the airplane, I should have been able to get there much sooner. It was not a well designed flight control system at all.

STEM 11 TEST 4
PILOT F
LONGITUDINAL CONFIGURATION 119
LATERAL CONFIGURATION 20

This is what I commonly call a sloppy flight control system. Problems in roll, yaw, and pitch. Its a rear axis problem here folks and I'm doing almost a 180° turn to fix it. I'm not qualified to fly this airplane. It's just real loose in all three axis. The pitch onset rate seems to be a little bit sluggish and it seems to have variable rate. I might be moving the stick or compensating more than I should, but basically the pitch rate starts, slows down, accelerates, when I go to back off it doesn't seem to back off until later then it stops. It decelerates at different rates and I feel like in both pitch, roll and yaw axis simultaneously. Trying to make pitch corrections I get a roll overshoot, I go to make a roll correction I get a pitch overshoot and yaw overshoot. I'm not having any trouble getting my nose up on it, its getting up there in the general area. The problem is with tracking. And the rates aren't predictable. This flight control system has a slow onset rate - its unpredictable onset rates. They seem to vary throughout the pull and then once you get near the target trying to stabilize it in a tracking situation it feels like you're trying to solve a three axis problem and its very sensitive to inputs.

STEM 11 TEST 4
PILOT A
LONGITUDINAL CONFIGURATION 120
LATERAL CONFIGURATION 11
CHR 2
PIO 2

This is a very nice harmonized configuration. It is getting there very quick and I am pulling a lot of g. If I try to rush it, I bobble around a little bit. My technique is to initiate a small pull, roll to get my lift vector on him, then pull to the target. If I hurry it, I get a littlePIO, but it stays within the desired reticle. Very nice blend. Very nice to fly. There is really no compensation involved. It is controllable, and adequate performance is attainable. Is it satisfactory? Yes. The only problem is a slight bobble when I get on the target. Once in awhile the bobbles take me to the edge of the circle, so that is the only minor problem. Otherwise negligible deficiencies. It is a good solid CHR 2. There is a slight PIO tendency but it is easily controlled. This is probably the nicest blend configuration that I saw.

STEM 11 TEST 4
PILOT F
LONGITUDINAL CONFIGURATION 120
LATERAL CONFIGURATION 11

Initial turn situation seemed to be okay. Fairly responsive in pitch and predictable in pitch. At the end though there was a little bit of PIO. It seemed like it was not very steady in the pitch tracking. It seemed to be sensitive to stick inputs, not as bad as the one before this (longitudinal configuration 19, lateral configuration 11) but still sensitive. I'm having to work on tracking the target and I'm having a pitch oscillation. I'm not fighting this configuration at all in roll and yaw like I was the

other one. The roll and yaw response seems to be good and the tracking capability seems to be good. The ability to control roll deceleration seems to be reasonable with the stick input. The pitch problem at the end game is causing major tracking problems. On that one, towards the end of the maneuver, there was a more aggressive pull and it caused a pitch overshoot and I had to go correct it. So, I'm going to have to back off the pitch rate if I want to do this at all well. In other words, slow down the rate of closure of the tracking reference for the target before it gets there.

STEM 11 TEST 4 (Range = 0.9 nm)
PILOT A
LONGITUDINAL CONFIGURATION 120
LATERAL CONFIGURATION 11
CHR 2
PIO 2

It worked pretty nicely. I have to get to the performance limit a little quicker. The airplane gets there very nicely. You get a very quick solution. It is very predictable. I am not at the performance limit of the airplane - it is not an open loop maneuver - I am not sitting with the stick on the aft stop. The rate is too high if I use full aft stick. Again, I am using the same technique. I am rolling over to him to get my lift vector on him as I am pulling up a little. And once I get my lift vector on him, then I am loading up to get my nose to track up to him. As I get up to him, I ease off a bit so that I can settle down the solution. Nice, smooth handling qualities. It is very predictable. If anything, it feels better here that at the other downrange. Probably because we are closer to the performance limit, so it takes away some of my variability. It is controllable, and adequate performance is attainable. Is it satisfactory without improvement? Yes. Very minimal compensation required. It is a very good flying airplane. There was a little bit of a tendency to PIO, which manifests itself here as undershooting. I am releasing the stick and it stops, so I apply the stick and it starts again. Just a little bit of an oscillation caused by a little bit of unpredictability. But it is easy to compensate for.

## Summary of Design Parameters Tested for STEM 11 TEST 5

Test variables:

LONDYN: Variations in a combination of longitudinal dynamics were implemented. The variations were expected to cover a range of poor and good dynamics:

- (-) Poor, (CAP=0.6/$\omega_{sp}$=1.067 at 100 KEAS, ZSP=0.35 for low AOA, ZSP=0.6 for high AOA, no longitudinal stick shaping)
- (+) Good, (CAP=0.6/$\omega_{sp}$=1.067, ZSP=0.7 for low AOA, ZSP=1.2 for high AOA, with longitudinal stick shaping)

AOAMAX: Indicates a maximum AOA or load factor depending on flight condition. This also indicates a variation in stick sensitivity:

Maximum AOA set at:

- (-) 40°, Aircraft can reach maximum lift but cannot reach post-stall
- (+) 60°, Aircraft can be flown post-stall

LATDYN: Variations in a combination of lateral dynamics were implemented. The variations were expected to cover a range of poor and good dynamics:

(-) poor, a schedule of TR and PMAX with AOA was implemented based on MIL-STD-1797A and MCAIR high AOA research.

| AOA | TR | PMAX |
|---|---|---|
| 5° | 0.6 sec | 150.0 deg/sec |
| 15° | 1.0 sec | 100.0 deg/sec |
| 30° | 1.8 sec | 40.0 deg/sec |
| 60° | 2.1 sec | 10.0 deg/sec |

(+) good, a schedule of TR and PMAX with AOA was implemented based on MIL-STD-1797A and MCAIR high AOA research.

| AOA | TR | PMAX |
|---|---|---|
| 5° | 0.4 sec | 180.0 deg/sec |
| 15° | 0.6 sec | 150.0 deg/sec |
| 30° | 1.0 sec | 90.0 deg/sec |
| 60° | 1.6 sec | 70.0 deg/sec |

RANGE: Indicates the two initial down ranges tested.

- (-) 1.3 nm, Nominal down range tested.
- (+) 0.9 nm, Minimum range tested.

## Range Test Matrix (Pilots A,F - Only Pilot A for range variation)

| Lon Config | Lat Config | LONDYN | AOAMAX | LATDYN | RANGE |
|---|---|---|---|---|---|
| 101 | 11 | Poor (-) | 7g/40° (-) | Good (+) | (-) Nominal |
| 126 | 20 | Good (+) | 7g/40° (-) | Poor (-) | (-) Nominal |
| 119 | 20 | Poor (-) | 9g/60° (+) | Poor (-) | (-) Nominal |
| 120 | 11 | Good (+) | 9g/60° (+) | Good (+) | (-) Nominal |
| 120 | 11 | Good (+) | 9g/60° (+) | Good (+) | (+) Minimum |

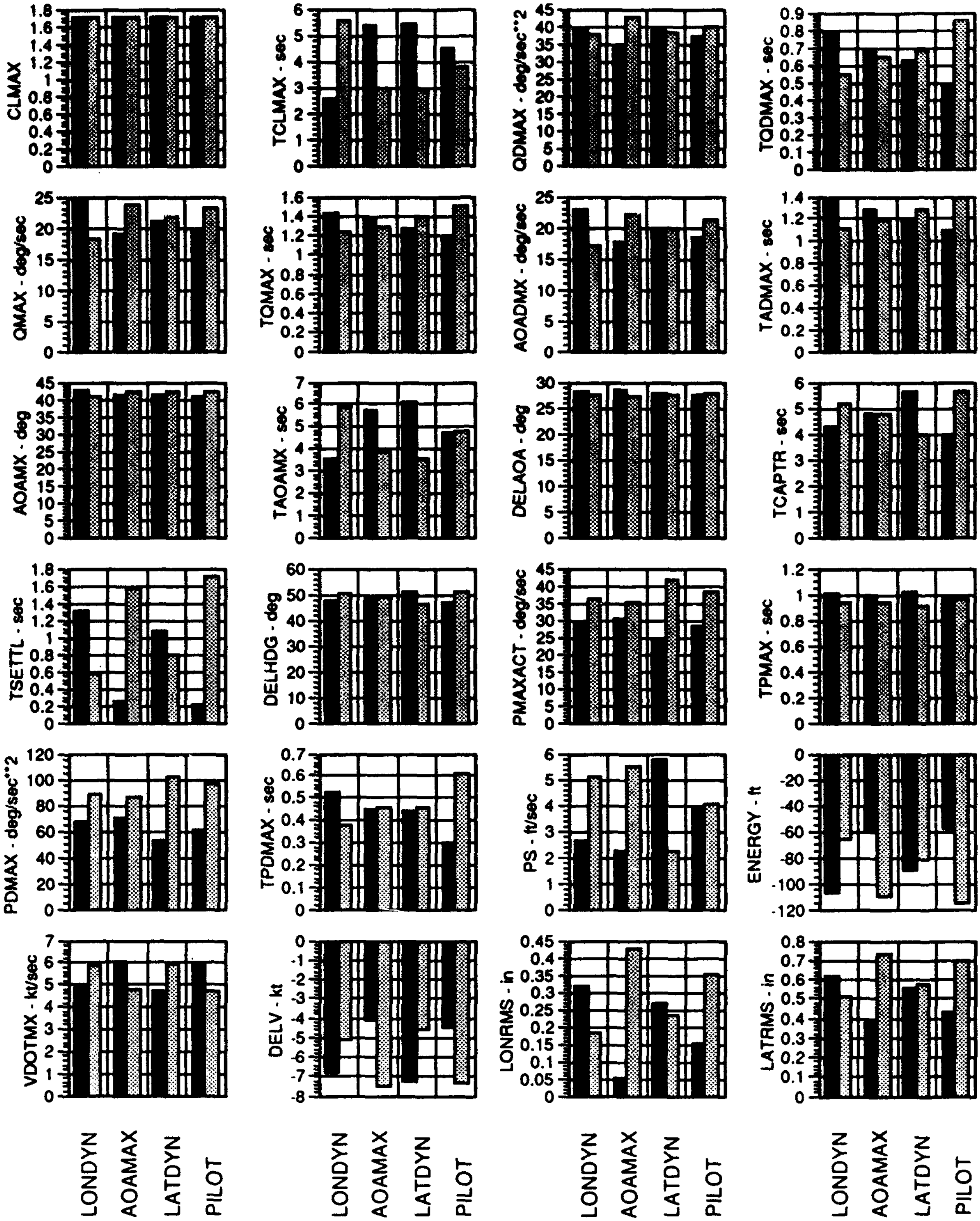
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | CLMAX | 0.9836 | LONDYN | 0.961 | 1.7201 | 1.7187 | 0 | 0 | -0.001 | 1.71 | 4 | 2 | 4 |
| | | | AOAMAX | 0.937 | 1.7188 | 1.7199 | 0 | 0 | 0.001 | 1.44 | 4 | 2 | 4 |
| | | | LATDYN | 0.993 | 1.7184 | 1.7203 | 0 | 0 | 0.001 | 2.33 | 4 | 1 | 4 |
| | | | PLT | 0.766 | 1.7198 | 1.719 | 0 | 0 | 0.000 | | | | |
| 3 | TCLMAX | 0.9999 | LONDYN | 1.000 | 2.5562 | 5.5933 | 0 | 0 | 0.866 | 4.80 | 1 | 1 | 1 |
| | | | AOAMAX | 1.000 | 5.3735 | 2.9927 | 0 | 0 | -0.619 | 3.44 | 1 | 1 | 1 |
| | | | LATDYN | 1.000 | 5.4471 | 2.9248 | 0 | 0 | -0.663 | 3.68 | 1 | 1 | 1 |
| | | | PLT | 0.994 | 4.489 | 3.7525 | 0 | 0 | -0.180 | | | | |
| 6 | QDMAX | 0.9621 | LONDYN | 0.426 | 39.407 | 37.755 | 0 | 0 | -0.043 | 0.58 | 4 | 3 | 4 |
| | | | AOAMAX | 0.995 | 33.814 | 42.918 | 0 | 0 | 0.241 | 3.29 | 2 | 1 | 2 |
| | | | LATDYN | 0.241 | 38.871 | 38.25 | 0 | 0 | -0.016 | 0.22 | 4 | 3 | 4 |
| | | | PLT | 0.699 | 37.193 | 40.017 | 0 | 0 | 0.073 | | | | |
| 7 | TQDMAX | 0.9999 | LONDYN | 1.000 | 0.7854 | 0.5433 | 0 | 0 | -0.377 | 0.62 | 2 | 3 | 4 |
| | | | AOAMAX | 0.489 | 0.6777 | 0.6427 | 0 | 0 | -0.053 | 0.09 | 4 | 3 | 4 |
| | | | LATDYN | 0.898 | 0.6305 | 0.6863 | 0 | 0 | 0.085 | 0.14 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 0.4813 | 0.8525 | 0 | 0 | 0.603 | | | | |
| 8 | QMAX | 0.9999 | LONDYN | 1.000 | 24.894 | 18.245 | 0 | 0 | -0.316 | 1.86 | 2 | 2 | 3 |
| | | | AOAMAX | 1.000 | 19.022 | 23.665 | 0 | 0 | 0.220 | 1.30 | 2 | 2 | 3 |
| | | | LATDYN | 0.545 | 21.134 | 21.716 | 0 | 0 | 0.027 | 0.16 | 4 | 3 | 4 |
| | | | PLT | 0.999 | 19.694 | 23.324 | 0 | 0 | 0.170 | | | | |
| 9 | TQMAX | 0.9998 | LONDYN | 0.994 | 1.4396 | 1.2356 | 0 | 0 | -0.153 | 0.62 | 3 | 3 | 4 |
| | | | AOAMAX | 0.834 | 1.386 | 1.285 | 0 | 0 | -0.076 | 0.31 | 4 | 3 | 4 |
| | | | LATDYN | 0.952 | 1.268 | 1.394 | 0 | 0 | 0.095 | 0.39 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 1.1775 | 1.5025 | 0 | 0 | 0.246 | | | | |
| 11 | AOADMX | 0.9999 | LONDYN | 1.000 | 22.936 | 17.107 | 0 | 0 | -0.297 | 2.16 | 2 | 1 | 2 |
| | | | AOAMAX | 1.000 | 17.635 | 22 | 0 | 0 | 0.223 | 1.62 | 2 | 2 | 3 |
| | | | LATDYN | 0.073 | 19.975 | 19.84 | 0 | 0 | -0.007 | 0.05 | 4 | 3 | 4 |
| | | | PLT | 0.993 | 18.591 | 21.328 | 0 | 0 | 0.138 | | | | |
| 12 | TADMAX | 0.9999 | LONDYN | 1.000 | 1.3687 | 1.1164 | 0 | 0 | -0.205 | 0.83 | 2 | 3 | 4 |
| | | | AOAMAX | 0.890 | 1.2902 | 1.1888 | 0 | 0 | -0.082 | 0.33 | 4 | 3 | 4 |
| | | | LATDYN | 0.914 | 1.193 | 1.2786 | 0 | 0 | 0.069 | 0.28 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 1.0929 | 1.3942 | 0 | 0 | 0.246 | | | | |
| 20 | AOAMX | 0.9999 | LONDYN | 1.000 | 42.785 | 40.718 | 0 | 0 | -0.050 | 1.44 | 4 | 2 | 4 |
| | | | AOAMAX | 0.999 | 41.082 | 42.29 | 0 | 0 | 0.029 | 0.84 | 4 | 3 | 4 |
| | | | LATDYN | 0.996 | 41.179 | 42.2 | 0 | 0 | 0.025 | 0.71 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 41.02 | 42.458 | 0 | 0 | 0.034 | | | | |
| 21 | TAOAMX | 0.9999 | LONDYN | 1.000 | 3.5604 | 5.8548 | 0 | 0 | 0.518 | 17.31 | 1 | 1 | 1 |
| | | | AOAMAX | 1.000 | 5.736 | 3.8465 | 0 | 0 | -0.410 | 13.71 | 1 | 1 | 1 |
| | | | LATDYN | 1.000 | 6.0888 | 3.5209 | 0 | 0 | -0.576 | 19.23 | 1 | 1 | 1 |
| | | | PLT | 0.128 | 4.6852 | 4.8275 | 0 | 0 | 0.030 | | | | |
| 23 | DELAOA | 0.9997 | LONDYN | 0.980 | 28.112 | 27.496 | 0 | 0 | -0.022 | 2.03 | 4 | 1 | 4 |
| | | | AOAMAX | 1.000 | 28.442 | 27.191 | 0 | 0 | -0.045 | 4.11 | 4 | 1 | 4 |
| | | | LATDYN | 0.693 | 27.959 | 27.637 | 0 | 0 | -0.012 | 1.06 | 4 | 2 | 4 |
| | | | PLT | 0.641 | 27.646 | 27.949 | 0 | 0 | 0.011 | | | | |
| 25 | TCAPTR | 0.9999 | LONDYN | 0.988 | 4.3229 | 5.1933 | 0 | 0 | 0.184 | 0.54 | 3 | 3 | 4 |
| | | | AOAMAX | 0.006 | 4.7569 | 4.7927 | 0 | 0 | 0.008 | 0.02 | 4 | 3 | 4 |
| | | | LATDYN | 1.000 | 5.6305 | 3.9863 | 0 | 0 | -0.352 | 1.02 | 2 | 2 | 3 |
| | | | PLT | 1.000 | 4.0044 | 5.6108 | 0 | 0 | 0.344 | | | | |
| 26 | TSETTL | 0.9999 | LONDYN | 0.959 | 1.3208 | 0.5731 | 0 | 0 | -0.935 | 0.23 | 1 | 3 | 3 |
| | | | AOAMAX | 0.999 | 0.2458 | 1.5654 | 0 | 0 | 3.105 | 0.76 | 1 | 3 | 3 |
| | | | LATDYN | 0.607 | 1.075 | 0.8 | 0 | 0 | -0.300 | 0.07 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 0.2077 | 1.7167 | 0 | 0 | 4.072 | | | | |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 28 | DELHDG | 0.9999 | LONDYN | 0.990 | 47.431 | 50.306 | 0 | 0 | 0.059 | 0.68 | 4 | 3 | 4 |
| | | | AOAMAX | 0.296 | 48.67 | 49.163 | 0 | 0 | 0.010 | 0.12 | 4 | 3 | 4 |
| | | | LATDYN | 1.000 | 51.33 | 46.707 | 0 | 0 | -0.095 | 1.09 | 4 | 2 | 4 |
| | | | PLT | 1.000 | 46.892 | 51.129 | 0 | 0 | 0.087 | | | | |
| 30 | PMAXACT | 0.9999 | LONDYN | 0.998 | 29.544 | 36.241 | 0 | 0 | 0.206 | 0.66 | 2 | 3 | 4 |
| | | | AOAMAX | 0.982 | 30.435 | 35.418 | 0 | 0 | 0.152 | 0.49 | 3 | 3 | 4 |
| | | | LATDYN | 1.000 | 23.651 | 41.681 | 0 | 0 | 0.597 | 1.91 | 1 | 2 | 2 |
| | | | PLT | 1.000 | 28.164 | 38.294 | 0 | 0 | 0.312 | | | | |
| 31 | TPMAX | 0.8279 | LONDYN | 0.667 | 1.0021 | 0.9356 | 0 | 0 | -0.069 | 5.93 | 4 | 1 | 4 |
| | | | AOAMAX | 0.454 | 0.9902 | 0.9465 | 0 | 0 | -0.045 | 3.89 | 4 | 1 | 4 |
| | | | LATDYN | 0.880 | 1.0263 | 0.9132 | 0 | 0 | -0.117 | 10.09 | 4 | 1 | 4 |
| | | | PLT | 0.038 | 0.9621 | 0.9733 | 0 | 0 | 0.012 | | | | |
| 32 | PDMAX | 0.9999 | LONDYN | 0.998 | 67.109 | 88.272 | 0 | 0 | 0.278 | 0.57 | 2 | 3 | 4 |
| | | | AOAMAX | 0.982 | 69.875 | 85.719 | 0 | 0 | 0.206 | 0.42 | 2 | 3 | 4 |
| | | | LATDYN | 1.000 | 52.209 | 102.03 | 0 | 0 | 0.721 | 1.48 | 1 | 2 | 2 |
| | | | PLT | 1.000 | 60.627 | 97.058 | 0 | 0 | 0.488 | | | | |
| 33 | TPDMAX | 0.9986 | LONDYN | 0.964 | 0.5229 | 0.3817 | 0 | 0 | -0.320 | 0.40 | 2 | 3 | 4 |
| | | | AOAMAX | 0.192 | 0.4444 | 0.4542 | 0 | 0 | 0.022 | 0.03 | 4 | 3 | 4 |
| | | | LATDYN | 0.219 | 0.443 | 0.4555 | 0 | 0 | 0.028 | 0.04 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 0.2967 | 0.615 | 0 | 0 | 0.795 | | | | |
| 36 | PS | 0.6989 | LONDYN | 0.656 | 2.6106 | 5.1364 | 0 | 0 | 0.730 | 15.72 | 4 | 1 | 4 |
| | | | AOAMAX | 0.762 | 2.2247 | 5.4925 | 0 | 0 | 1.032 | 22.23 | 4 | 1 | 4 |
| | | | LATDYN | 0.830 | 5.7432 | 2.2447 | 0 | 0 | -1.084 | 23.35 | 2 | 1 | 2 |
| | | | PLT | 0.080 | 3.8365 | 4.0187 | 0 | 0 | 0.046 | | | | |
| 37 | ENERGY | 0.9999 | LONDYN | 0.999 | -107.62 | -65.291 | 0 | 0 | 0.521 | 0.70 | 1 | 3 | 3 |
| | | | AOAMAX | 1.000 | -58.855 | -110.31 | 0 | 0 | -0.670 | 0.90 | 1 | 3 | 3 |
| | | | LATDYN | 0.536 | -89.427 | -82.088 | 0 | 0 | 0.086 | 0.12 | 4 | 3 | 4 |
| | | | PLT | 1.000 | -58.036 | -115.48 | 0 | 0 | -0.744 | | | | |
| 38 | VDOTMX | 0.6685 | LONDYN | 0.691 | 4.835 | 5.8957 | 0 | 0 | 0.200 | 0.83 | 4 | 3 | 4 |
| | | | AOAMAX | 0.784 | 6.0402 | 4.7832 | 0 | 0 | -0.235 | 0.98 | 4 | 3 | 4 |
| | | | LATDYN | 0.768 | 4.7402 | 5.9832 | 0 | 0 | 0.235 | 0.98 | 4 | 3 | 4 |
| | | | PLT | 0.763 | 5.9973 | 4.7249 | 0 | 0 | -0.241 | | | | |
| 39 | DELV | 0.9999 | LONDYN | 0.897 | -6.7491 | -5.0639 | 0 | 0 | 0.291 | 0.57 | 3 | 3 | 4 |
| | | | AOAMAX | 0.997 | -4.1146 | -7.4957 | 0 | 0 | -0.636 | 1.24 | 1 | 2 | 2 |
| | | | LATDYN | 0.987 | -7.2552 | -4.5966 | 0 | 0 | 0.472 | 0.92 | 1 | 3 | 3 |
| | | | PLT | 0.990 | -4.4981 | -7.362 | 0 | 0 | -0.513 | | | | |
| 42 | LONRMS | 0.9999 | LONDYN | 0.960 | 0.3195 | 0.1846 | 0 | 0 | -0.576 | 0.61 | 1 | 3 | 3 |
| | | | AOAMAX | 1.000 | 0.0536 | 0.43 | 0 | 0 | 3.951 | 4.21 | 1 | 1 | 1 |
| | | | LATDYN | 0.491 | 0.2659 | 0.2341 | 0 | 0 | -0.128 | 0.14 | 4 | 3 | 4 |
| | | | PLT | 0.997 | 0.1531 | 0.3536 | 0 | 0 | 0.938 | | | | |
| 43 | LATRMS | 0.9979 | LONDYN | 0.707 | 0.6166 | 0.5118 | 0 | 0 | -0.187 | 0.38 | 4 | 3 | 4 |
| | | | AOAMAX | 0.998 | 0.3779 | 0.7321 | 0 | 0 | 0.710 | 1.46 | 1 | 2 | 2 |
| | | | LATDYN | 0.076 | 0.5524 | 0.571 | 0 | 0 | 0.033 | 0.07 | 4 | 3 | 4 |
| | | | PLT | 0.988 | 0.4366 | 0.6981 | 0 | 0 | 0.487 | | | | |
| 44 | ELEVRMS | 0.9625 | LONDYN | 0.251 | 0.8939 | 0.9381 | 0 | 0 | 0.048 | 0.09 | 4 | 3 | 4 |
| | | | AOAMAX | 0.866 | 0.805 | 1.0202 | 0 | 0 | 0.239 | 0.43 | 3 | 3 | 4 |
| | | | LATDYN | 0.733 | 0.9929 | 0.8468 | 0 | 0 | -0.160 | 0.29 | 4 | 3 | 4 |
| | | | PLT | 0.998 | 0.686 | 1.167 | 0 | 0 | 0.557 | | | | |
| 45 | AZIMRMS | 0.9819 | LONDYN | 0.968 | 1.3536 | 1.0002 | 0 | 0 | -0.307 | 1.51 | 2 | 2 | 3 |
| | | | AOAMAX | 0.866 | 1.0534 | 1.2773 | 0 | 0 | 0.194 | 0.95 | 4 | 3 | 4 |
| | | | LATDYN | 0.542 | 1.1127 | 1.2225 | 0 | 0 | 0.094 | 0.46 | 4 | 3 | 4 |
| | | | PLT | 0.864 | 1.0564 | 1.2927 | 0 | 0 | 0.203 | | | | |

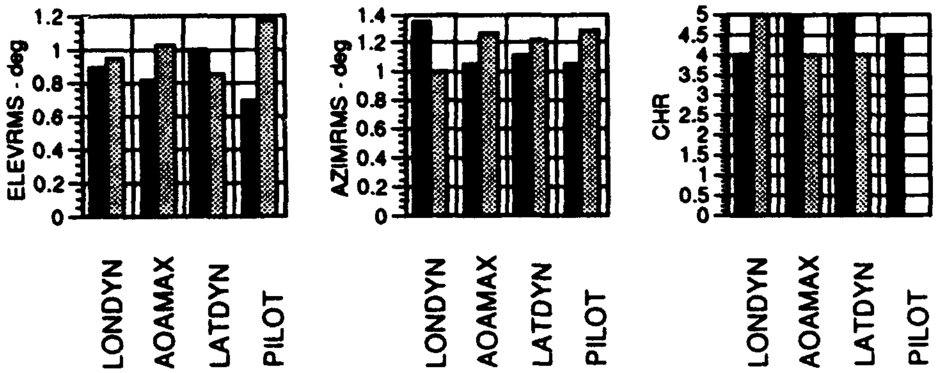
STEM 11 TEST 5

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 49 | CHR | 0 | LONDYN | -999 | 4 | 5 | 0 | 0 | 0.225 | 0.00 | 4 | 3 | 4 |
| | | | AOAMAX | -999 | 5 | 4 | 0 | 0 | -0.225 | 0.00 | 4 | 3 | 4 |
| | | | LATDYN | -999 | 5 | 4 | 0 | 0 | -0.225 | 0.00 | 4 | 3 | 4 |
| | | | PLT | -999 | 4.5 | -999 | 0 | 0 | -112.002 | | | | |

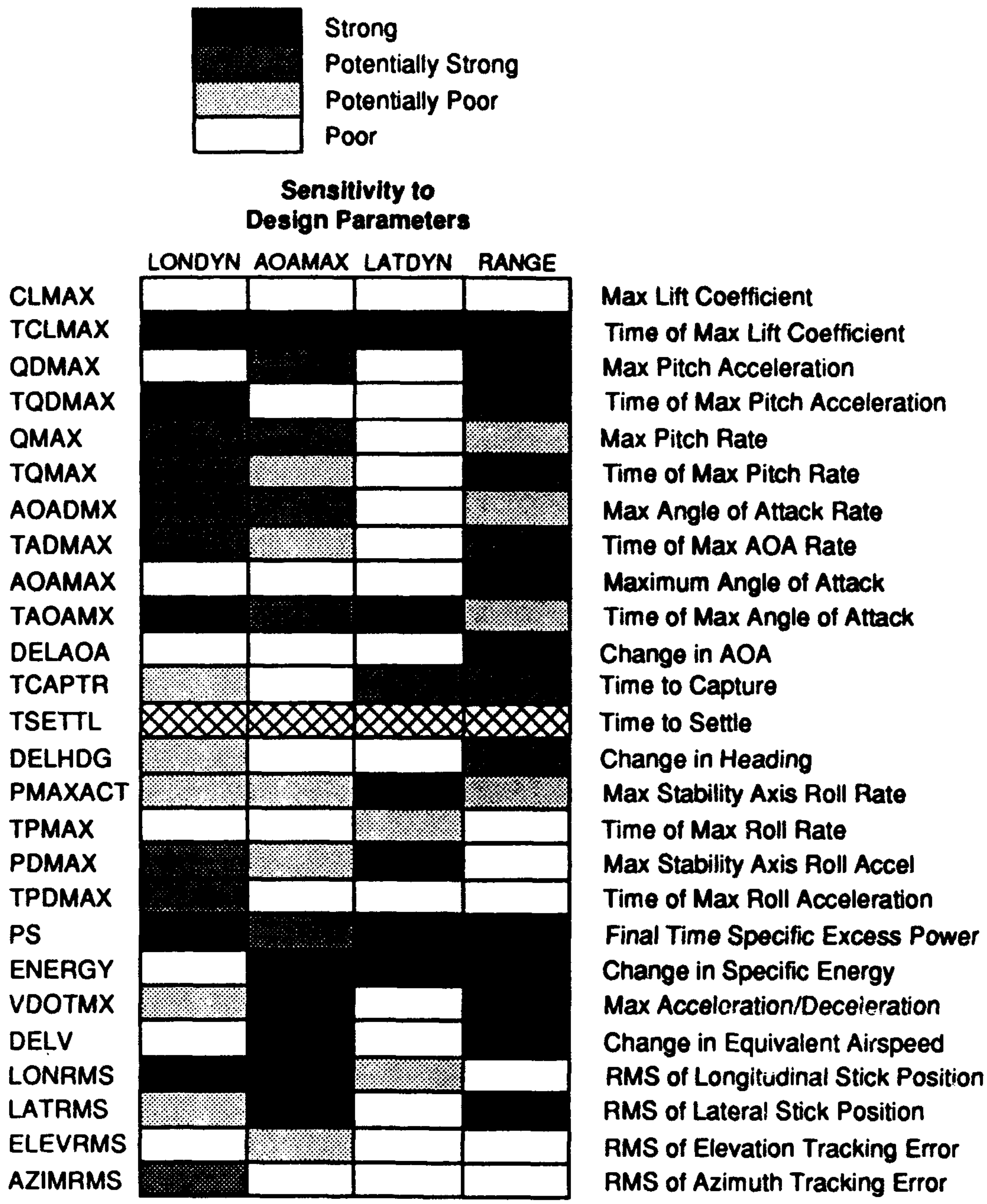
STEM 11 TEST 5



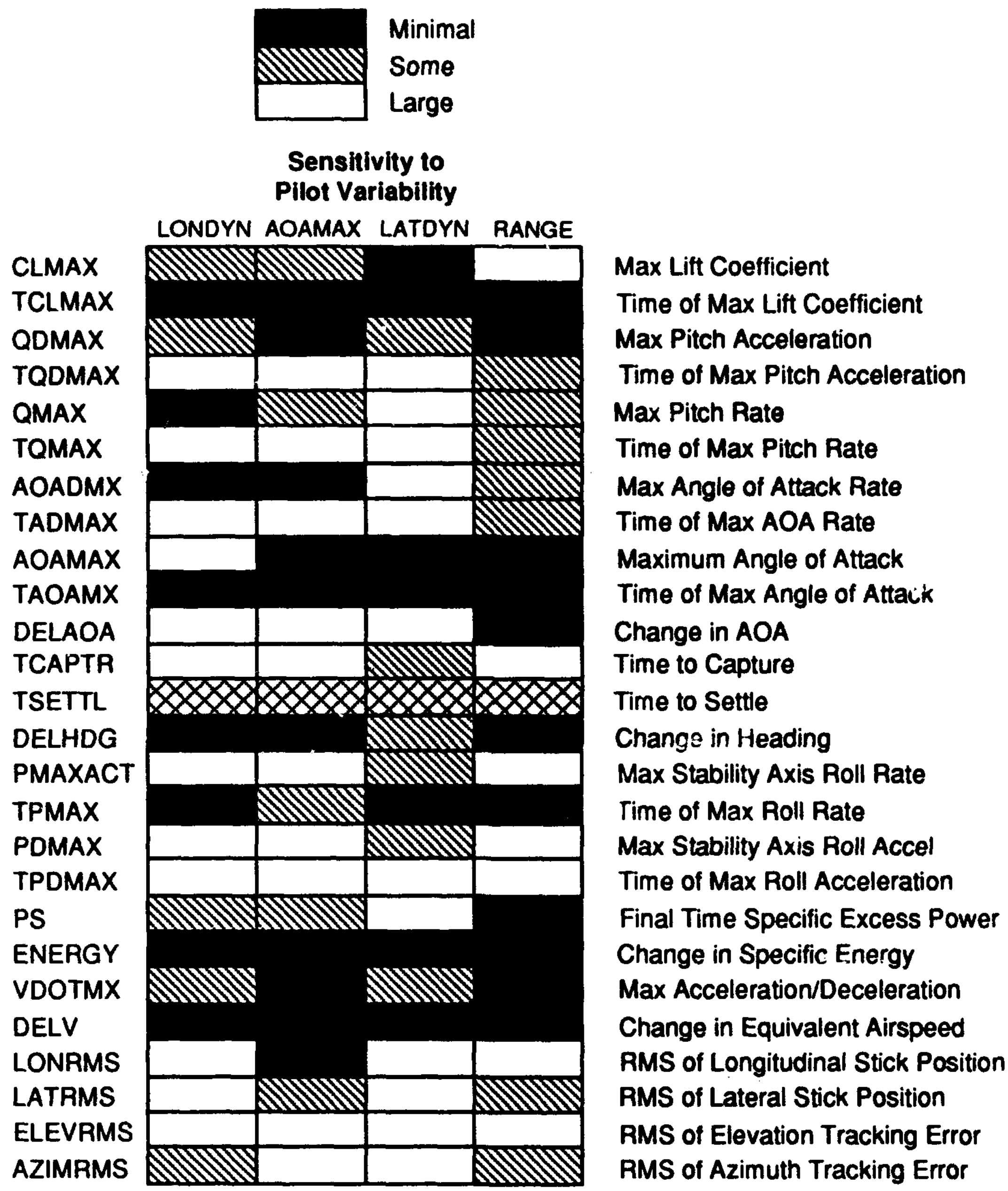
STEM 11 TEST 5



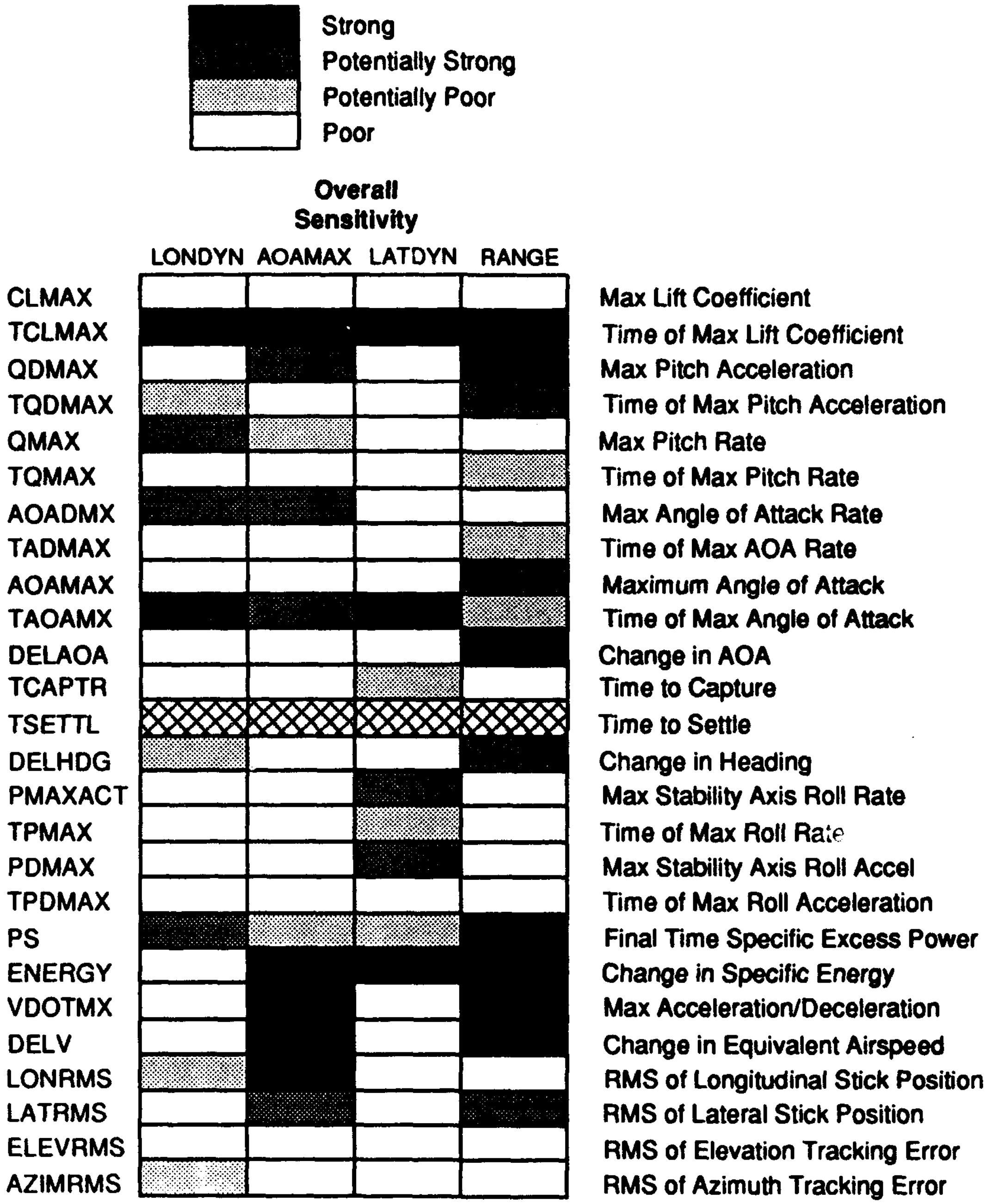
STEM 11 TEST 5



STEM 11 TEST 5



STEM 11 TEST 5



STEM 11 TEST 5
PILOT A
LONGITUDINAL CONFIGURATION 126
LATERAL CONFIGURATION 20
CHR 6
PIO 1

That's too slow. It feels like a last ditch maneuver. It's just so sluggish that if you didn't get away with that you're not going to get away with anything anymore this way. The pitch response is so slow that any problems laterally are masked because you have so much time to get it up laterally that you can make very small corrections and walk it in very nicely as you're slowly waiting for the nose to come up. My technique is to go full aft stick and just hold it there and wait and wait and wait until the nose comes up and then slowly play lateral to make sure it comes inside. Is it controllable. Is adequate performance attainable with tolerable pilot workload? Yes. That is adequate pitch performance but not desired pitch performance. Satisfactory without improvement? No. It doesn't really require pilot compensation, it requires pilot patience. But do I call that pitch response moderately objectionable or very objectionable? I have to call that very objectionable but tolerable because I'm making it there. I'm sitting forever with the nose back waiting for the nose to come up. Its just so slow. This would be the last thing I could do in a fight because I know by the time I come out of this thing I've exposed myself for so long that I'm going to get shot by somebody else. Laterally it's okay. I still have pretty nice lateral response. I could play it left and right and as I said I have so much time waiting for the pitch that I can do whatever I want laterally. PIO - there's no tendency for PIOs because things just happen so slowly.

STEM 11 TEST 5
PILOT F
LONGITUDINAL CONFIGURATION 126
LATERAL CONFIGURATION 20

This is sluggish in pitch. It is coming up to the target very slowly. Not much trouble in roll and yaw capture and not much trouble at all in pitch capture but very, very sluggish response to pitch. The rate at which the pipper closed toward the target was noticeably slower than the preceding configuration (longitudinal configuration 101, lateral configuration 20). The capture was not nearly as great of a problem as the last configuration. Basically it feels like to me you have a much slower pitch onset rate and I don't have. It appears to me to be sensitive to roll and yaw although I'm not putting hardly any roll and yaw stick deflections in so its hard for me to tell how rapidly thats moving. The capture is not a problem. Once I get the nose on him I don't have any oscillation in roll, yaw or pitch. It just stablized on target without any capture oscillations. I think the roll is pretty sluggish too. That time I overrolled if you want to call it that. My pipper was inside and below the target and I had to counter-roll back. In other words I started off with a right hand pitch and rolling maneuever and I rolled too far to the right. When I came back to correct left it was very sluggish in left hand roll reversal from my original roll direction. So I suspect we got a sluggish roll axis also. Although again once you're on the target there is very good damping and no capture problem. It just takes a long time to get there.

STEM 11 TEST 5
PILOT A
LONGITUDINAL CONFIGURATION 101
LATERAL CONFIGURATION 11
CHR 4
PIO 1

The method is to roll slightly while pulling on the stick to get the full aft stick and then hold the full aft stick with your nose slowly falling towards the target and then use a very small lateral correction to hold on the target to get it to stay there for 2 seconds. There's no tendency to overshoot. It is very easy to get there because we're performance limited. Thats all it'll do. It's a little sluggish, I mean I have to hold the stick and it slowly comes up and then it caps out - that's the most pitch angle change I can get out of the airplane. So it would be nice if we had more pitch response. I'll go through the Cooper Harper and my criteria will be need to track it for 2 seconds. No more than one overshoot was desired, two overshoots was adequate and we're looking for an appropriate amount of time. It was always controllable. I never had any overshoots so it is definitely desired. It is just a matter of time - whether that was fast enough to be adequate. Is it satisfactory without improvement? It was too slow. It gets there, the trouble is it's just that's all the airplane will give me. The capture is dead easy because it just gets there automatically. The problem with it is just a very sluggish nose. It would be nice if it came up a lot quicker. So I'm going to call it a CHR 4, with the problem being the nose is too slow. It gets there in a reasonable amount of time - just about 3 seconds or 4 seconds but I should have more capacity than that. Otherwise it's fine. And there's no tendency to PIO at all. The nose just stays there.

STEM 11 TEST 5
PILOT F
LONGITUDINAL CONFIGURATION 101
LATERAL CONFIGURATION 11

When I get up to high angle of attack I'm having a little bit of a yaw control problem. The pitch doesn't seem to be the problem. I'm having some roll control problems on the final tracking. It's a sensitivity problem. I started a PIO in what appears to be yaw from the cockpit. I don't know what the angle of attack is but I'm sure its like 45 or so. That time I affected capture by using a little bit of rudder. I haven't been using rudder on these so I'm going to start using rudder. The pitch is fine. It gets me there in plenty of time. Good, crisp onset rate and no problem with the unload. It seems to be good on loaded characteristics but at that point in time I'm not paying too much attention to pitch because I'm having to get myself aligned in roll-yaw to put my pipper on the target.

STEM 11 TEST 5
PILOT A
LONGITUDINAL CONFIGURATION 119
LATERAL CONFIGURATION 20
CHR 4
PIO 2

Well this one is good in pitch but it's not very good directionally. This one has got an F-18 kind of alpha with it. I'm missing it laterally though and my lateral response isn't good enough in harmony with the pitch response that I can predictably get him. Because of the high alpha the roll looks like yaw. And that's why it appears to come in from the side. I just can't hurry the pitch any more than that because it's too unpredictable laterally. The lateral controls are the limiting factor. And if you get an overshoot you end up with a lateral overshoot. That's about the best I can do walking it in there and I sort of approach it from an 8:00 position and anticipate the fade out of lateral controls to get a good capture. That was very typical, I ended up with a full 35 to 40 mil overshoot down to the 8:00 position as I attempted to capture it quickly. I stayed within desired criteria. Have to work fairly hard and › a lot of stick shaping to make sure that the lateral acquisition works. ‿ots of pitch power. The control harmony is not very good. I need more lateral-directional power to match the amount of pitch power that I have. This is a good maneuver to measure the harmony of the controls. That was a little better capture because I was much more graceful on my lateral input. Is it controllable? Yes. Is adequate performance attainable? Yes. I get there quickly. Satisfactory without improvement? I'm going to say no. It is a minor and annoying deficiency in the lateral control axis in that it takes moderate pilot compensation to anticipate where the nose is going to go so I don't dutch roll myself off of my tracking solution. Its easy to get an overshoot. You have to pay attention. But if I do pay attention then I can hit desired performance with moderate workload. PIO rating. There is a small tendency to PIO. I can prevent or eliminate it like I did on the last one by very smoothly putting it in and letting it damp itself out. So as long as I provide a low gain kind of filter then I can stop it from getting into a PIO. In order to improve this one I need a proportionate increase in lateral-direction control to match the amount of pitch response that I have.

STEM 11 TEST 5
PILOT F
LONGITUDINAL CONFIGURATION 119
LATERAL CONFIGURATION 20

Very rapid roll. Hard to capture. It is very sensitive in pitch and roll and probably yaw accelerations. Very sensitive to any kind of stick input. Again, I'm not trimming, so the stick is trying to go back to its 0 force position and I'm trying to hold it on the target. This is like kind of throwing it up there and hoping you're close when you get there because any corrections once you get close are difficult.

STEM 11 TEST 5
PILOT A
LONGITUDINAL CONFIGURATION 120
LATERAL CONFIGURATION 11
CHR 4
PIO 3

Its easy to get into a lateral PIO. I am slowing down my pitch rate to make my lateral more predictable and give me time to settle it out. There is a good lateral PIO there. On that last one I tried to drive my pitch rate to a maximum and the lateral response drove me to a plus minus 40 PIO. Because of the limited amount of time to settle them down. Again not really nice harmony. Fairly predictable in pitch. No PIO tendency in pitch but laterally it feels like my response was too slow. I had the power available it's just hard to anticipate it. Now there was a great example of a lateral PIO. I messed it up because I tried to hurry the pitch too much. I bounced out one side and then out the other. So I'll slow the pitch down a little bit this time - see if I can smooth it out. And that's how it looks when you smooth out the pitch. Get in there much easier. You don't sacrifice much time. Was it controllable? Yes. Was adequate performance attainable with a tolerable pilot workload? Yes. Is is satisfactory without improvement? I don't think so. Minimal pilot compensation required for desired performance - mildly unpleasant deficiencies. I had enough pitch response, in fact I had more pitch response available than I could use due to the poor lateral-directional qualities. My lateral qualities were difficult to predict, especially when I was hurrying it by using all of my pitch response. Again it's a matter of harmony between longitudinal and lateral so that you get an equal amount of predictability so you can use the limit's of both. So to improve this I think the time response of the lateral handling quality needs to be improved so that I don't get behind the curve on those. PIOs - definitely a tendency, easily induced. It was easy to get a left/right PIO going and then I had to be very smooth in my inputs to get rid of it.

STEM 11 TEST 5
PILOT F
LONGITUDINAL CONFIGURATION 120
LATERAL CONFIGURATION 11

The oscillations weren't as bad about the target with that one. In other words the capture sensitivities weren't as difficult but I still have the same type of problems, they weren't as severe. First of all, there is a pitch up to capture the target in the pitch axis. And that's usually no problem. But once you get into the pitch axis, because the target is moving and roll is required to keep continual aligning within the plane of motion, this arcing that's a direct function of angle of attack starts moving the pipper in a small arc across the target so you're constantly doing roll corrections, trying to get the pipper back on him. So its not a question of just rolling, pitching and capturing; it's pitch, roll, capture and slowly continue roll and pitch while you're tracking and the combination of trying to track while rolling is complicating the problem because of the arcing around the velocity vector. Its not as bad in this configuration as the one previous but I think you're going to see this pretty typical of any kind of maneuever like this when you got pitch and roll combined maneuvering going on at high angle of attack. Again, nice pitch onset rate. No problem getting there in pitch. Once up there though the roll is oversensitive and there is a capture problem.

STEM 11 TEST 5 (Downrange = 0.9 nm)
PILOT A
LONGITUDINAL CONFIGURATION 120
LATERAL CONFIGURATION 11
CHR -
PIO -

That's the performance limit of the airplane so it's an open loop task. I put my lift vector on him, I pull the stick to my left and I just wait until the red lights come on so there's not much to rate. He's staying in for about 2-1/2 maybe 3 seconds. That's all it'll give me. It's pretty straightforward, I roll about 3/4 of the amount of roll required while burying the stick in my lap and then let the last quarter of the lateral fall through as I'm arcing through my pitch axis so that they combine together to catch the target at the same time. That's pretty straightforward.

STEM 11 TEST 6
PILOT F
LONGITUDINAL CONFIGURATION 752
LATERAL CONFIGURATION 11

It requires lots of back stick to get the rate started and I am pushing against the forward stop to slow it down. I'm actually unloading and going to the opposite stop but the nose is not responding. It's slowing down. So I am going to full back to get the rate onset because if it don't, I don't think it's going to move very quickly. And then as it gets about two-thirds the way up to the target, I'm unloading to stop the forward rate and getting a capture. If I keep it loaded up to when I get near the target, I overshoot so bad that I have to unload. I really am pushing full forward stick to get the pipper back down towards the target. It's like pitching basketballs. You know, just kind of lob it up there and then try and stop it. I don't like this flight control system. If you slow the rate down it's not too bad. There is a definite lag in the system.

STEM 11 TEST 6
PILOT F
LONGITUDINAL CONFIGURATION 707
LATERAL CONFIGURATION 11

That had a lot heavier stick forces. The onset rate isn't nearly as much. This airplane has a very sluggish nose and when you use full aft stick it comes. It doesn't seem to be to much different in the rate between full aft stick and mid-stick. It's a lot more sluggish in overall maximum pitch, although it seems to be a very sensitive stick for tracking. I'm having trouble when I get there tracking it because when I unload a little bit I get a fairly large oscillation in pitch. When I unload the airplane the nose stops and then small stick movements cause the nose to bobble up and down. But as far as putting the stick in your lap and getting it to rate around, it doesn't want to do that very well. The stick seems awful heavy too.

STEM 11 TEST 6
PILOT F
LONGITUDINAL CONFIGURATION 719
LATERAL CONFIGURATION 11

This one feels good. Nice onset rate in pitch, and stabilized tracking when I got to the top. I liked that configuration. It has nice pitch onset rate. Tracking wasn't too difficult when I didn't hand-fist it. There was a little bit of lag between the stick and the nose position but not nearly what the other ones were.

STEM 11 TEST 6
PILOT F
LONGITUDINAL CONFIGURATION 709
LATERAL CONFIGURATION 11

You need minor stick inputs to these. This has a very sensitive stick. The problem is not getting up there; the problem is tracking him once you're there because it's so sensitive in pitch. The slightest input

causes a 50-60 mil correction. So, I'm getting in a PIO when I get up to the top of him.

STEM 11 TEST 6
PILOT F
LONGITUDINAL CONFIGURATION 729
LATERAL CONFIGURATION 11

This is sort of like a slinky. It kind of ripples up there and then when you get there it sort of slops around. In other words, I put the stick in and it starts moving okay and then all of a sudden when I try to stop it it's like it just has its momentum and floats out there. It's not real rapid. And when I put the opposite stick in it floats back down. It's not that the rate onset is much slower than the other ones. The onset rate is a little bit slow to start and kind of floats up there. And when you start getting near it and you try to stop it, it just floats right on by him and sits up there a little while and comes back and then trying to track him you have the same slow oscillations. You put a stick control input to correct it and nothing happens for awhile.

## Data Contents for STEM 12: High AOA Reversal

TEST 1: Maneuver tested at Vmin, 45°AOA, 180° heading change

- Summary of Design Parameter Variations Tested
- Numerical Summary of Statistical Analysis
- Bar Graphs of Measures of Merit
- Design Parameter Correlations, Pilot Variability, and Overall Correlations
- Pilot Comments

TEST 2: Maneuver tested at Vmin, 45°AOA, 90° heading change

- Summary of Design Parameter Variations Tested
- Numerical Summary of Statistical Analysis
- Bar Graphs of Measures of Merit
- Design Parameter Correlations, Pilot Variability, and Overall Correlations
- Pilot Comments

**Summary of Design Parameters Tested for STEM 12 TEST 1**

Test variables:

TR: Indicates the stability axis roll mode time constant. Values at 45° AOA are:
(-) 1.95 sec, Approximately Level 2/3 (at 45° AOA) from MCAIR research
(+) 1.3 sec, Approximately Level 1/2 (at 45° AOA) from MCAIR research

PMAX: Indicates the maximum stability axis roll rate available from a full stick input. Also directly affects the lateral stick sensitivity:
(-) 40 deg/sec, Approximately Level 2/3 (at 45° AOA) from MCAIR research
(+) 80 deg/sec, Approximately Level 1/2 (at 45° AOA) from MCAIR research

PDLIM: Roll acceleration limiter:
(-) No limiter,
(+) Limiter on, Roll acceleration limited - most strongly affects aggressive crosschecks.

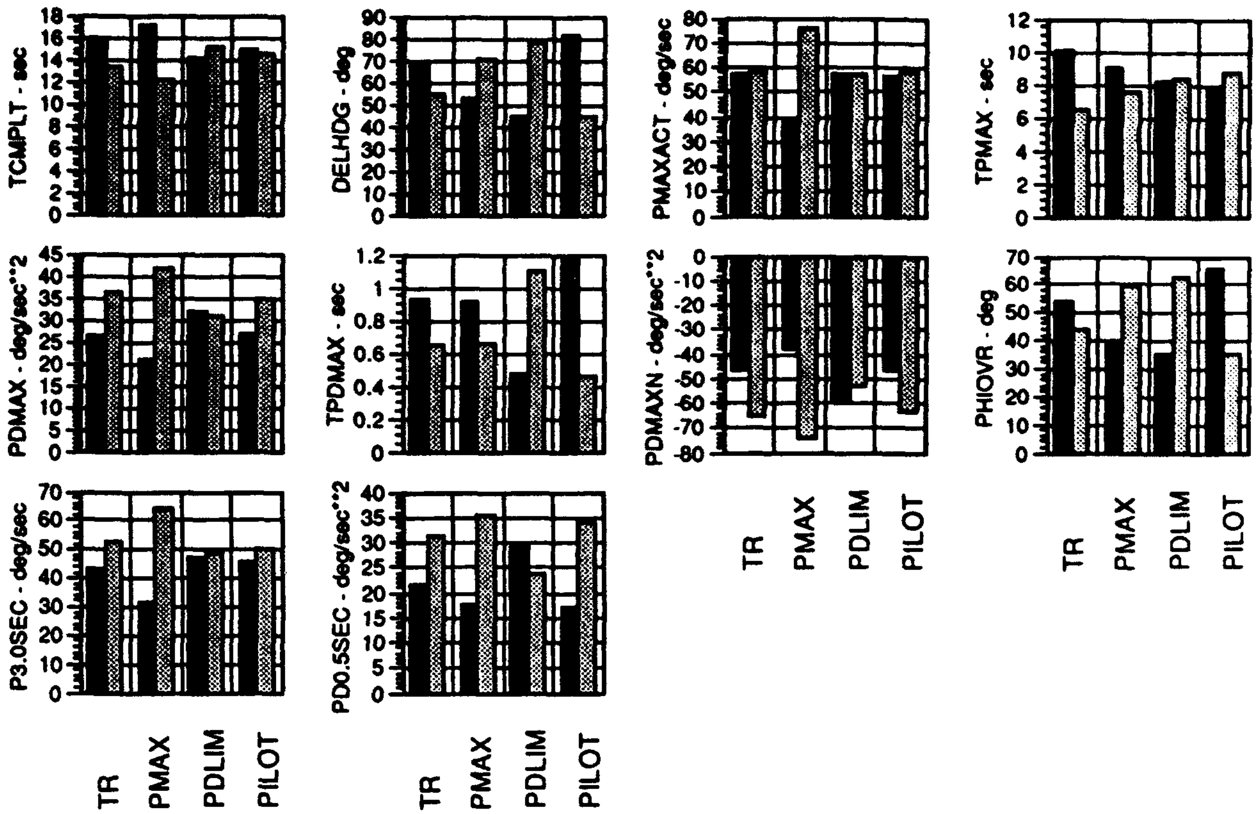
**Test Matrix (Pilots D,G)**

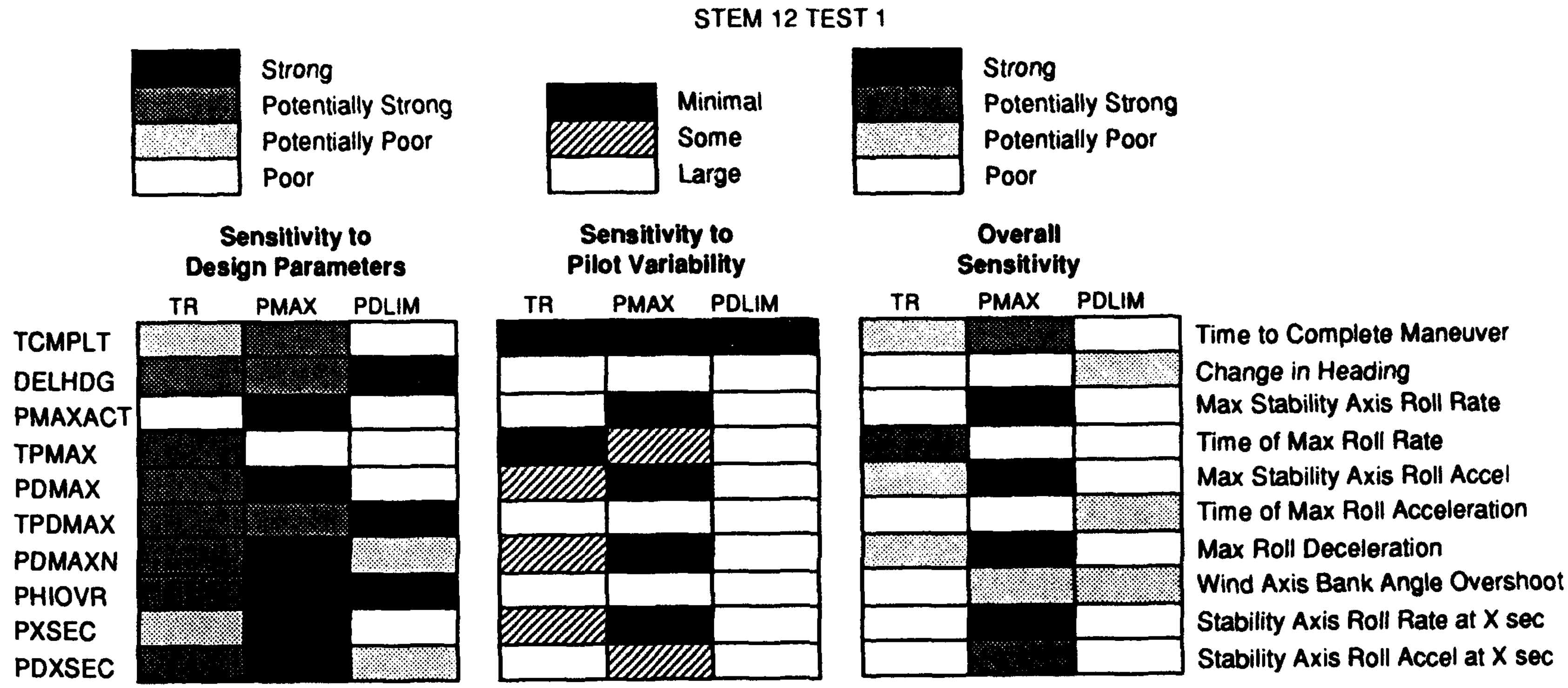
| Lon Config | Lat Config | TR | PMAX | PDLIM |
|---|---|---|---|---|
| 152 | 16 | 1.95 (-) | 40 (-) | On (+) |
| 152 | 13 | 1.30 (+) | 40 (-) | Off (-) |
| 152 | 12 | 1.95 (-) | 80 (+) | Off (-) |
| 152 | 17 | 1.30 (+) | 80 (+) | On (+) |

STEM 12 TEST 1

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 27 | TCMPLT | 0.9999 | TR | 1.000 | 15.85 | 13.417 | 0 | 0 | -0.167 | 5.75 | 3 | 1 | 3 |
| | | | PMAX | 1.000 | 17.206 | 12.061 | 0 | 0 | -0.363 | 12.46 | 2 | 1 | 2 |
| | | | PDLIM | 1.000 | 14.055 | 15.212 | 0 | 0 | 0.079 | 2.72 | 4 | 1 | 4 |
| | | | PLT | 0.963 | 14.868 | 14.441 | 0 | 0 | -0.029 | | | | |
| 28 | DELHDG | 0.9999 | TR | 0.998 | 68.958 | 54.272 | 0 | 0 | -0.242 | 0.38 | 2 | 3 | 4 |
| | | | PMAX | 1.000 | 52.295 | 70.935 | 0 | 0 | 0.310 | 0.48 | 2 | 3 | 4 |
| | | | PDLIM | 1.000 | 44.556 | 78.674 | 0 | 0 | 0.600 | 0.94 | 1 | 3 | 3 |
| | | | PLT | 1.000 | 82.077 | 44.873 | 0 | 0 | -0.641 | | | | |
| 30 | PMAXACT | 0.9999 | TR | 0.793 | 57.376 | 57.892 | 0 | 0 | 0.009 | 0.24 | 4 | 3 | 4 |
| | | | PMAX | 1.000 | 39.129 | 76.139 | 0 | 0 | 0.716 | 19.59 | 1 | 1 | 1 |
| | | | PDLIM | 0.739 | 57.405 | 57.863 | 0 | 0 | 0.008 | 0.22 | 4 | 3 | 4 |
| | | | PLT | 0.999 | 56.478 | 58.58 | 0 | 0 | 0.037 | | | | |
| 31 | TPMAX | 0.3591 | TR | 0.881 | 10.09 | 6.5168 | 0 | 0 | -0.451 | 3.81 | 2 | 1 | 2 |
| | | | PMAX | 0.505 | 9.0513 | 7.5555 | 0 | 0 | -0.182 | 1.53 | 4 | 2 | 4 |
| | | | PDLIM | 0.054 | 8.2303 | 8.3765 | 0 | 0 | 0.018 | 0.15 | 4 | 3 | 4 |
| | | | PLT | 0.510 | 7.768 | 8.7414 | 0 | 0 | 0.118 | | | | |
| 32 | PDMAX | 0.9999 | TR | 1.000 | 26.209 | 36.323 | 0 | 0 | 0.332 | 1.23 | 2 | 2 | 3 |
| | | | PMAX | 1.000 | 20.662 | 41.87 | 0 | 0 | 0.767 | 2.83 | 1 | 1 | 1 |
| | | | PDLIM | 0.702 | 31.795 | 30.737 | 0 | 0 | -0.034 | 0.13 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 26.755 | 34.957 | 0 | 0 | 0.271 | | | | |
| 33 | TPDMAX | 0.9999 | TR | 1.000 | 0.9349 | 0.6418 | 0 | 0 | -0.385 | 0.35 | 2 | 3 | 4 |
| | | | PMAX | 1.000 | 0.9163 | 0.6605 | 0 | 0 | -0.333 | 0.30 | 2 | 3 | 4 |
| | | | PDLIM | 1.000 | 0.4702 | 1.1065 | 0 | 0 | 0.964 | 0.87 | 1 | 3 | 3 |
| | | | PLT | 1.000 | 1.1903 | 0.4596 | 0 | 0 | -1.102 | | | | |
| 34 | PDMAXN | 0.9999 | TR | 1.000 | -46.78 | -64.97 | 0 | 0 | -0.334 | 1.03 | 2 | 2 | 3 |
| | | | PMAX | 1.000 | -37.24 | -74.51 | 0 | 0 | -0.750 | 2.31 | 1 | 1 | 1 |
| | | | PDLIM | 1.000 | -58.71 | -53.04 | 0 | 0 | 0.102 | 0.31 | 3 | 3 | 4 |
| | | | PLT | 1.000 | -46.29 | -63.71 | 0 | 0 | -0.325 | | | | |
| 35 | PHIOVR | 0.9999 | TR | 1.000 | 54.505 | 43.94 | 0 | 0 | -0.217 | 0.34 | 2 | 3 | 4 |
| | | | PMAX | 1.000 | 38.961 | 59.484 | 0 | 0 | 0.436 | 0.68 | 1 | 3 | 3 |
| | | | PDLIM | 1.000 | 35.398 | 63.047 | 0 | 0 | 0.610 | 0.95 | 1 | 3 | 3 |
| | | | PLT | 1.000 | 65.652 | 35.78 | 0 | 0 | -0.645 | | | | |
| 46 | PXSEC | 0.9999 | TR | 1.000 | 43.652 | 52.343 | 0 | 0 | 0.183 | 1.82 | 3 | 2 | 4 |
| | (3.0 sec) | | PMAX | 1.000 | 31.347 | 64.648 | 0 | 0 | 0.789 | 7.88 | 1 | 1 | 1 |
| | | | PDLIM | 0.784 | 47.447 | 48.548 | 0 | 0 | 0.023 | 0.23 | 4 | 3 | 4 |
| | | | PLT | 0.543 | 45.374 | 50.144 | 0 | 0 | 0.100 | | | | |
| 47 | PDXSEC | 0.9999 | TR | 1.000 | 21.496 | 31.502 | 0 | 0 | 0.392 | 0.53 | 2 | 3 | 4 |
| | (0.5 sec) | | PMAX | 1.000 | 17.48 | 35.518 | 0 | 0 | 0.770 | 1.04 | 1 | 2 | 2 |
| | | | PDLIM | 0.977 | 29.067 | 23.93 | 0 | 0 | -0.196 | 0.26 | 3 | 3 | 4 |
| | | | PLT | 1.000 | 17.195 | 34.111 | 0 | 0 | 0.740 | | | | |

STEM 12 TEST 1




STEM 12 TEST 1
Strong
Potentially Strong
Potentially Poor
Poor
Minimal
Some
Large
Strong
Potentially Strong
Potentially Poor
Poor
Sensitivity to Design Parameters
Sensitivity to Pilot Variability
Overall Sensitivity
TR
PMAX
PDLIM
TCMPLT
DELHDG
PMAXACT
TPMAX
PDMAX
TPDMAX
PDMAXN
PHIOVR
PXSEC
PDXSEC
Time to Complete Maneuver
Change in Heading
Max Stability Axis Roll Rate
Time of Max Roll Rate
Max Stability Axis Roll Accel
Time of Max Roll Acceleration
Max Roll Deceleration
Wind Axis Bank Angle Overshoot
Stability Axis Roll Rate at X sec
Stability Axis Roll Accel at X sec

STEM 12 TEST 1
PILOT C
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 16

The lateral dynamics are not real good. Large time constant, and the overshoot is about 120 degrees or thereabouts so precision would be compromised. The only way I can get a decent shot at the split-S part of it is to use about a half stick input and give it lots of lead on rolling out. So there's a fair amount of compensation required to capture bank angles. And that's a little disconcerting since I'm starting at fairly low angle of attack, around 15 degrees. This would be a difficult task in a lot of places in the country, Edwards being one of them, because what you need is a long section line. You need something like a river or a highway that goes 10 miles on either side so that you could pin your heading to it. In other words, you need something that is not right underneath you.

STEM 12 TEST 1
PILOT D
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 16

It seemed that holding the alpha precisely is tough during the reversal, and I guess sometimes it seems to climb, sometimes it seems to decrease. It's kind of hard to tell where 180 degrees is. I'm just kind of visually trying to get the gouge. The lateral seemed a little bit sluggish, but I didn't really key in on it.

STEM 12 TEST 1
PILOT G
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 16

It was actually an easier maneuver than I anticipated it to be. I did the whole thing in idle and I was a little rushed getting into it with the nose low, but the nose really dropped down when I came when I rolled over. We lose around a little over 2,000 feet in the maneuver. This is definitely a different maneuver, but its not as difficult to fly as I anticipated. The alpha control within ±5 is reasonable. You have to work at that a little bit. I'd be tempted to try to do this at a faster airspeed. You just feel real sluggish rolling in at such a slow airspeed, but you probably need it that way so that you end up getting to the higher alpha as you come with the nose coming through the vertical. The only question mark in this whole data taking thing would probably be the heading changes. I can't get a good feel for exactly when I go past the 180, when I go the other way, but if you're just looking for rates it'll probably be okay. The airplane seems to respond smoothly through the thing. Its a very controlled maneuver.

STEM 12 TEST 1
PILOT C
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 13

This set up is a lot easier. Roll control is more precise. It overshoots, but it overshoots by a predictable amount. Much better roll control. It overshoots only about 20 degrees. That's good. In fact, this may be too good. That's a much more precise configuration. It's easy to establish the IC. You can use full stick, you can use half stick or any combination thereof. Fairly precise roll control. The overshoot is 20 to 30 degrees which tells me it's probably a little crisp. Maybe a little high lateral acceleration in the cockpit. But it's very predictable. I'm sure with a little practice you could probably do a heading capture with something like that. Roll control is good.

STEM 12 TEST 1
PILOT D
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 13

It seemed like it was pretty snappy when it reversed. Maybe there was some delay, but it seemed like it was going the way I wanted to go and it was fairly comfortable. It felt like there is a definite nose up tendency on the reversal. It seems to me there is a definite tendency to gain about 5 degrees alpha during the reversal. I would then modulate the stick forward a little bit to get rid of it. And the longitudinal inputs are very small and fairly easy to control. Toward the end of the turn, when I get within 40 degrees of the end of the 180 degree turn, the alpha is very controllable within ± 2 degrees alpha.

STEM 12 TEST 1
PILOT G
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 13

It seems like it would be great to do this the simulator but in the airplane it kind of opens a whole can of worms from safety considerations. If I had put a target out there and had to just pirouette around to that target and stop the nose, it seems like it would be pretty easy. Like I said, the airplane tracks fairly smoothly. These aren't outrageously high rates.

STEM 12 TEST 1
PILOT C
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 12

That one really winds up. That's got more roll rate capability than you need and as a consequence if you hold that lateral stick all the way in you're going to continue to wind up and roll. You get a hellatious rate. You can't stop it. The initial roll to the inverted is controllable. You just want to watch your rate, keep the rate reasonable or you're going to overshoot it. About a 90 degree overshoot. It's amazing how that thing wants to wrap up like that. Okay, if I was going to be doing this for

real, probably about half way through that, I would be starting to take out lateral stick. That rate's getting pretty high.

STEM 12 TEST 1
PILOT D
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 12

Much faster turn rate. It appears to be significantly more responsive than the other configurations (lateral configurations 16 and 13). You can go through a 180 degrees a whole lot faster in this configuration.

STEM 12 TEST 1
PILOT G
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 12

It is definitely quicker. It seems to roll quicker,. It might be difficult to track something here, because it does have such a quick rate. In fact I'm probably bringing out the lateral stick prior to the 180, but in terms of handling qualities I kind of like that one versus the others. It seemed more responsive.

STEM 12 TEST 1
PILOT C
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 17

That's got more roll rate than you need. I'd be quite comfortable with about half stick on that entire maneuver, or maybe stuffing it in and then taking it back out. In other words, trading off steady state roll rate to get a faster effective time constant.

STEM 12 TEST 1
PILOT D
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 17

It's kind of hard to tell if it feels any quicker than the other one (lateral configuration 12), but it's also really brisk.

STEM 12 TEST 1
PILOT G
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 17

I think this is a little bit faster yet. I didn't lose nearly as much altitude, which would be another indication that was a much faster capability, which I guess would be important. I think I like this configuration best of all of them. I'm getting used to being able to lead it and stop it. I think that one I stopped just about right at 180 and went back around the other direction. Its pretty predictable and I think one of the fastest rates we've seen.

## Summary of Design Parameters Tested for STEM 12 TEST 2

Test variables:

TR: Indicates the stability axis roll mode time constant. Values at 45° AOA are:
(-) 1.95 sec, Approximately Level 2/3 (at 45° AOA) from MCAIR research
(+) 1.3 sec, Approximately Level 1/2 (at 45° AOA) from MCAIR research

PMAX: Indicates the maximum stability axis roll rate available from a full stick input. Also directly affects the lateral stick sensitivity:
(-) 40 deg/sec, Approximately Level 2/3 (at 45° AOA) from MCAIR research
(+) 80 deg/sec, Approximately Level 1/2 (at 45° AOA) from MCAIR research

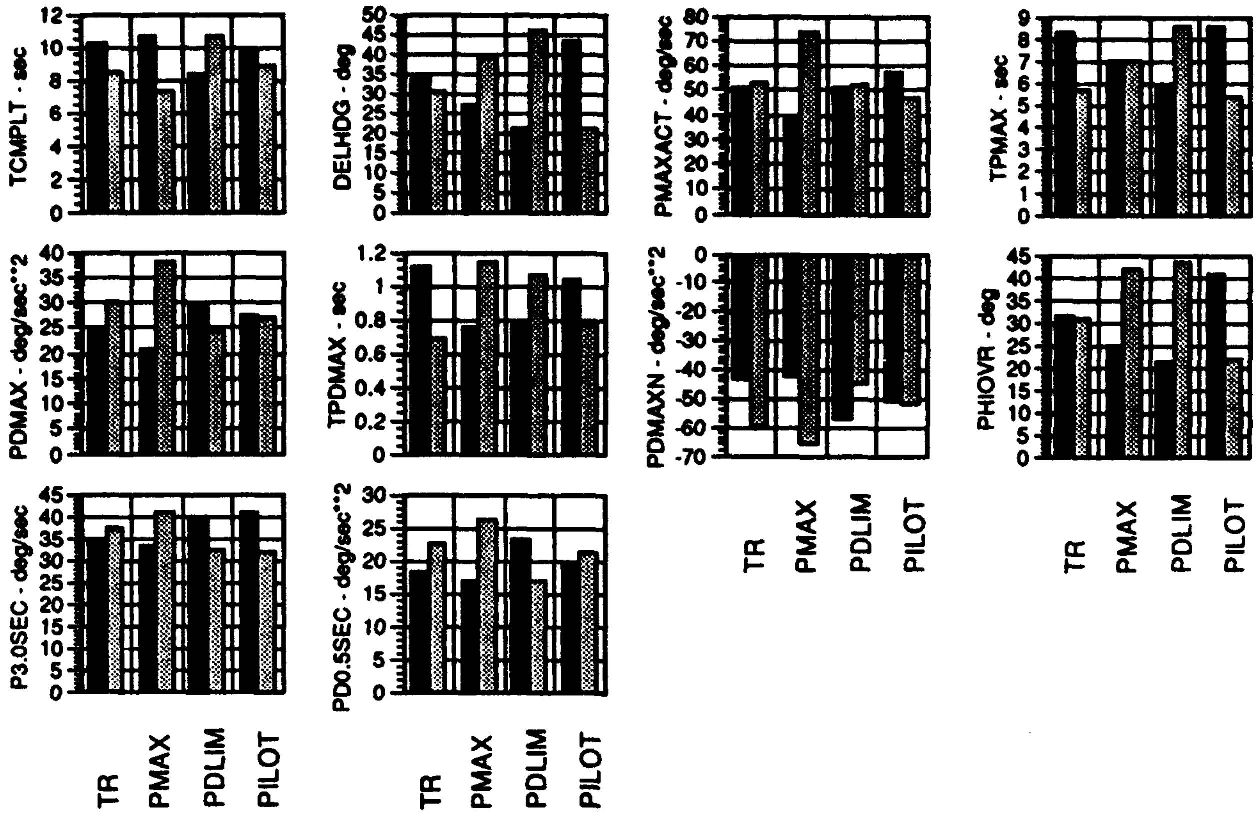
PDLIM: Roll acceleration limiter:
(-) No limiter,
(+) Limiter on, Roll acceleration limited - most strongly affects aggressive crosschecks.

### Test Matrix (Pilots F,G)

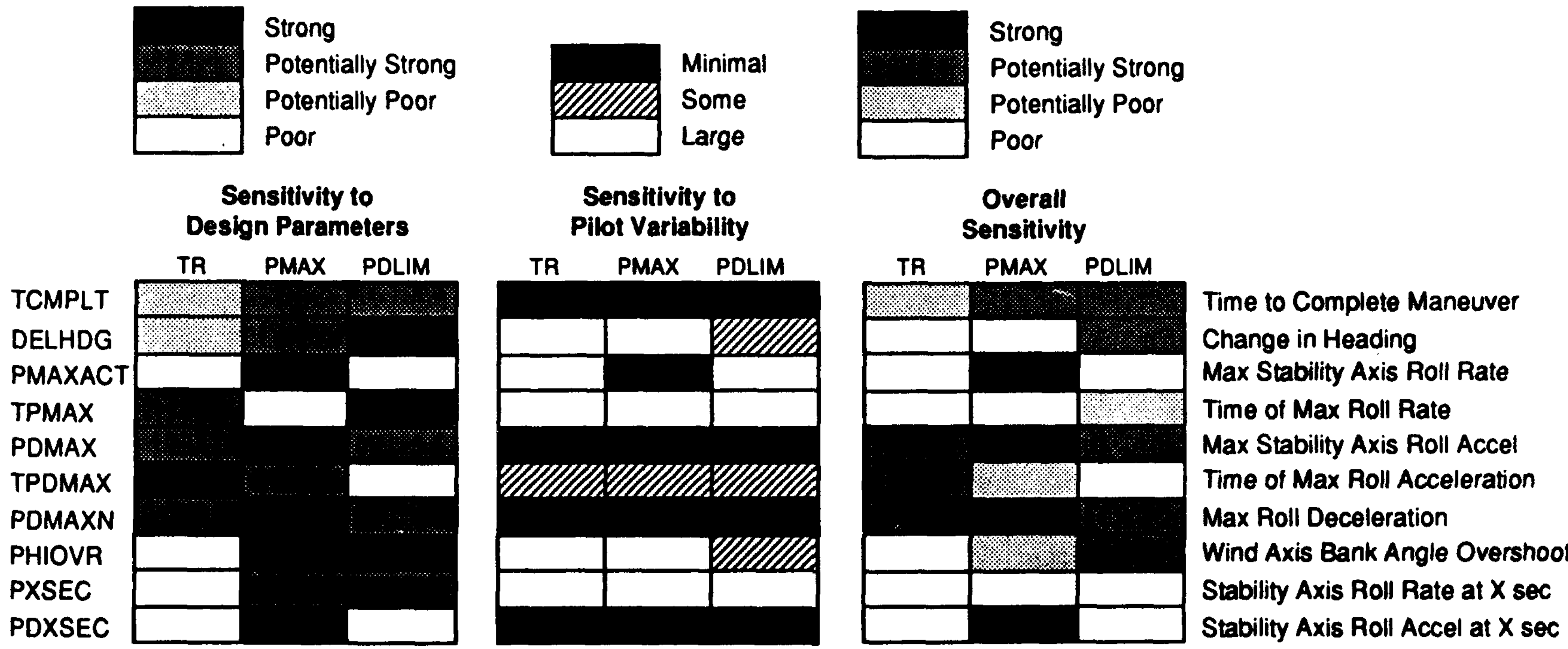
| Lon Config | Lat Config | TR | PMAX | PDLIM |
|---|---|---|---|---|
| 152 | 16 | 1.95 (-) | 40 (-) | On (+) |
| 152 | 13 | 1.30 (+) | 40 (-) | Off (-) |
| 152 | 12 | 1.95 (-) | 80 (+) | Off (-) |
| 152 | 17 | 1.30 (+) | 80 (+) | On (+) |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 27 | TCMPLT | 0.9999 | TR | 1.000 | 10.218 | 8.424 | 0 | 0 | -0.194 | 2.21 | 3 | 1 | 3 |
| | | | PMAX | 1.000 | 10.598 | 7.3134 | 0 | 0 | -0.380 | 4.31 | 2 | 1 | 2 |
| | | | PDLIM | 1.000 | 8.2899 | 10.61 | 0 | 0 | 0.249 | 2.83 | 2 | 1 | 2 |
| | | | PLT | 0.999 | 9.7307 | 8.9111 | 0 | 0 | -0.088 | | | | |
| 28 | DELHDG | 0.9999 | TR | 0.917 | 33.792 | 30.099 | 0 | 0 | -0.116 | 0.15 | 3 | 3 | 4 |
| | | | PMAX | 1.000 | 27.145 | 39.488 | 0 | 0 | 0.384 | 0.49 | 2 | 3 | 4 |
| | | | PDLIM | 1.000 | 20.942 | 45.7 | 0 | 0 | 0.862 | 1.10 | 1 | 2 | 2 |
| | | | PLT | 1.000 | 42.948 | 20.943 | 0 | 0 | -0.782 | | | | |
| 30 | PMAXACT | 0.9999 | TR | 0.456 | 51.134 | 52.582 | 0 | 0 | 0.028 | 0.13 | 4 | 3 | 4 |
| | | | PMAX | 1.000 | 38.319 | 73.134 | 0 | 0 | 0.692 | 3.21 | 1 | 1 | 1 |
| | | | PDLIM | 0.728 | 51.627 | 52.147 | 0 | 0 | 0.010 | 0.05 | 4 | 3 | 4 |
| | | | PLT | 0.982 | 57.382 | 46.334 | 0 | 0 | -0.215 | | | | |
| 31 | TPMAX | 0.9658 | TR | 0.960 | 8.3067 | 5.6351 | 0 | 0 | -0.398 | 0.82 | 2 | 3 | 4 |
| | | | PMAX | 0.201 | 6.9666 | 6.9777 | 0 | 0 | 0.002 | 0.00 | 4 | 3 | 4 |
| | | | PDLIM | 0.921 | 5.7348 | 8.516 | 0 | 0 | 0.406 | 0.83 | 1 | 3 | 3 |
| | | | PLT | 0.989 | 8.5807 | 5.3611 | 0 | 0 | -0.488 | | | | |
| 32 | PDMAX | 0.9999 | TR | 1.000 | 24.331 | 30.256 | 0 | 0 | 0.220 | 11.62 | 2 | 1 | 2 |
| | | | PMAX | 1.000 | 20.576 | 37.849 | 0 | 0 | 0.648 | 34.26 | 1 | 1 | 1 |
| | | | PDLIM | 0.999 | 29.688 | 24.3 | 0 | 0 | -0.202 | 10.66 | 2 | 1 | 2 |
| | | | PLT | 0.992 | 27.551 | 27.035 | 0 | 0 | -0.019 | | | | |
| 33 | TPDMAX | 0.9725 | TR | 0.916 | 1.1178 | 0.6851 | 0 | 0 | -0.509 | 1.74 | 1 | 2 | 2 |
| | | | PMAX | 0.834 | 0.7484 | 1.142 | 0 | 0 | 0.435 | 1.49 | 2 | 2 | 3 |
| | | | PDLIM | 0.625 | 0.7748 | 1.0597 | 0 | 0 | 0.318 | 1.09 | 4 | 2 | 4 |
| | | | PLT | 0.726 | 1.0307 | 0.7722 | 0 | 0 | -0.293 | | | | |
| 34 | PDMAXN | 0.9999 | TR | 1.000 | -43.38 | -59.22 | 0 | 0 | -0.316 | 12.27 | 2 | 1 | 2 |
| | | | PMAX | 1.000 | -41.97 | -65.97 | 0 | 0 | -0.468 | 18.15 | 1 | 1 | 1 |
| | | | PDLIM | 0.999 | -56.79 | -44.44 | 0 | 0 | 0.248 | 9.61 | 2 | 1 | 2 |
| | | | PLT | 0.995 | -50.64 | -51.96 | 0 | 0 | -0.026 | | | | |
| 35 | PHIOVR | 0.9999 | TR | 0.211 | 31.501 | 31.022 | 0 | 0 | -0.015 | 0.02 | 4 | 3 | 4 |
| | | | PMAX | 1.000 | 24.706 | 41.563 | 0 | 0 | 0.544 | 0.82 | 1 | 3 | 3 |
| | | | PDLIM | 1.000 | 21.456 | 43.518 | 0 | 0 | 0.768 | 1.16 | 1 | 2 | 2 |
| | | | PLT | 1.000 | 40.7 | 21.823 | 0 | 0 | -0.664 | | | | |
| 46 | PXSEC | 0.9999 | TR | 0.846 | 35.025 | 37.532 | 0 | 0 | 0.069 | 0.26 | 4 | 3 | 4 |
| | (3.0 sec) | | PMAX | 0.999 | 33.383 | 40.828 | 0 | 0 | 0.203 | 0.77 | 2 | 3 | 4 |
| | | | PDLIM | 0.998 | 39.624 | 32.096 | 0 | 0 | -0.212 | 0.81 | 2 | 3 | 4 |
| | | | PLT | 1.000 | 40.96 | 31.597 | 0 | 0 | -0.262 | | | | |
| 47 | PDXSEC | 0.9685 | TR | 0.769 | 18.066 | 22.685 | 0 | 0 | 0.230 | 3.44 | 4 | 1 | 4 |
| | (0.5 sec) | | PMAX | 0.976 | 16.767 | 26.047 | 0 | 0 | 0.455 | 6.81 | 1 | 1 | 1 |
| | | | PDLIM | 0.791 | 23.176 | 16.875 | 0 | 0 | -0.323 | 4.83 | 4 | 1 | 4 |
| | | | PLT | 0.572 | 19.695 | 21.056 | 0 | 0 | 0.067 | | | | |

STEM 12 TEST 2



STEM 12 TEST 2



STEM 12 TEST 2
PILOT C
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 16

A lot of overshoot. Even with a full check in, the last one was at least a 90° overshoot. I can't get the precise control that I want on the initial 180° roll. It looks like about 65-70° of overshoot on the first check. This configuration would not be capable of precise control. And I don't seem to be able to trade rate for quickness on the split-S.

STEM 12 TEST 2
PILOT F
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 16

Interesting, the velocity vector is not pointing straight down on these things. It is kind of cork-screwing around. This one has a lot of nose hunting going on. This has a lot more pitch oscillation when I'm doing the roll. In other words, the nose is hunting high or low. Maybe I rolled in a little slow that time. Let me try and get in faster. It's doing the same thing but not as bad. I think my slow entry caused it that last time. But it's definitely got a lot more oscillation in pitch as I'm doing the rolls. The roll rate is okay. It just doesn't feel very controlled. It's got the slow reversal and the nose floats. That's what is causing it.

STEM 12 TEST 2
PILOT G
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 16

It is hard to tell when I hit my second 90. It seemed like I was able to see when I reached the first 90 pretty well. It seemed like I overturned the 90 on that but I'm not sure how much of that was me not seeing when I reached 90 or just a lag in the control system as I overshot it but I already have the stick coming back to the right. It seems like I'm still holding alpha fairly well but I'm not allowed to keep an eye on it when I look outside.

STEM 12 TEST 2
PILOT C
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 13

The time constant is a little excessive. But the overshoot, for this task, is predictable. I am not having a problem on the split-s portion. I am getting very nearly 180° of bank. The overshoot is there. You couldn't do a precision heading capture using full stick, but you could come close. So that is only fair.

STEM 12 TEST 2
PILOT F
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 13

This one is a lot slower in the roll. The entry is controllable, but so is the other one (lateral configuration 12). This has equal entry controllability as far as I'm concerned, but the roll is slower.

STEM 12 TEST 2
PILOT G
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 13

I haven't seen much difference in this configuration versus the previous (lateral configuration 13). It seems it may be a little easier to control angle of attack during the roll but I haven't seen much difference in the performance. It may be just a hair faster but it's really hard to tell. I don't see a whole lot of difference between the 2 configurations.

STEM 12 TEST 2
PILOT C
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 12

That's a little more precise. Establishing the 180 bank was considerably easier. I still don't want to use full stick. The overshoot is 40-50° on the initial check. It's about 60 degrees on the second one. Precise control is there. You've got the possibility for precision control. I'd be tempted not to want to use full lateral stick or not leave full lateral stick in. I'd be tempted to initiate it and immediately back away. It's controllable and the bank angle overshoot is predictable. You could live with that. That's probably not too far from a very desirable set of dynamics.

STEM 12 TEST 2
PILOT F
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 12

This one is quick but it's more stable. This one is just a tad slower than the other one (lateral configuration 17) but a lot more stable. This one is very quick on the lateral comeback also. Not as quick as the other one. It didn't wrap up as fast, but it is very quick. That one was just a little more damped. I was more comfortable with it. In other words, it's plenty fast, but it's more controllable.

STEM 12 TEST 2
PILOT G
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 12

These dynamics are definitely faster. There is a tendency to overshoot. That's a quicker response. Definitely a very quick roll. The 90 degree

turn happens pretty quick in this configuration. That's a pretty good overshoot. It builds up some good rates. That looks about 40 to 60 degrees per second. It seems like the initial response is comfortable, it's quick but it's comfortable but it really builds up. That would be good if you want to make a lot of heading changes but as we saw you get a pretty big overshoot after you reverse the controls.

STEM 12 TEST 2
PILOT C
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 17

It continues to wrap up in roll rate. On the first 90 degrees I probably get a 70 degree overshoot which is a little on the high side but you can live with it. When I reverse it I get more like 120 degrees because now I'm going the 90 plus the 70. It's got that much more time to wrap up in roll.

STEM 12 TEST 2
PILOT F
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 17

It's immensely easier doing an unloaded roll into this thing. These 90 degree heading cahnges are going to be tough. It comes quick in this one.Wow, that's impressive. I got back to that 90 degree mark quick. That had some incredible lateral roll capability. I rolled 90 degrees, it had a lot of momentum, and when I come to the stop point and reversed, it came back around fairly crisply and then *really* wrapped up. There is a rapid acceleration if you keep the roll in beyond about 90 degrees. It went to 180 so fast I couldn't believe it. In other words, it went to 90 degrees real quick, but I could stop it. Then when I came back with full roll authority the opposite way, the thing would wrap up really quick.

STEM 12 TEST 2
PILOT G
LONGITUDINAL CONFIGURATION 152
LATERAL CONFIGURATION 17

Another fast one. Even a little faster than the one before (lateral configuration 12) I think. A very fast, very similar response to the previous configuration. It doesn't look like it overshoots quite as much. I think you have a little better capability to do a controlled reversal.

## Data Contents for STEM 13: High AOA Roll and Capture

TEST 1: AOA Command systems

- Summary of Design Parameter Variations Tested
- Numerical Summary of Statistical Analysis
- Bar Graphs of Measures of Merit
- Design Parameter Correlations, Pilot Variability, and Overall Correlations
- Pilot Comments

## Summary of Design Parameters Tested for STEM 13

Test variables:
- TR: Indicates a variation in roll mode time constant:
  - (-) 1.4, Level 2
  - (+) 0.6, Level 1

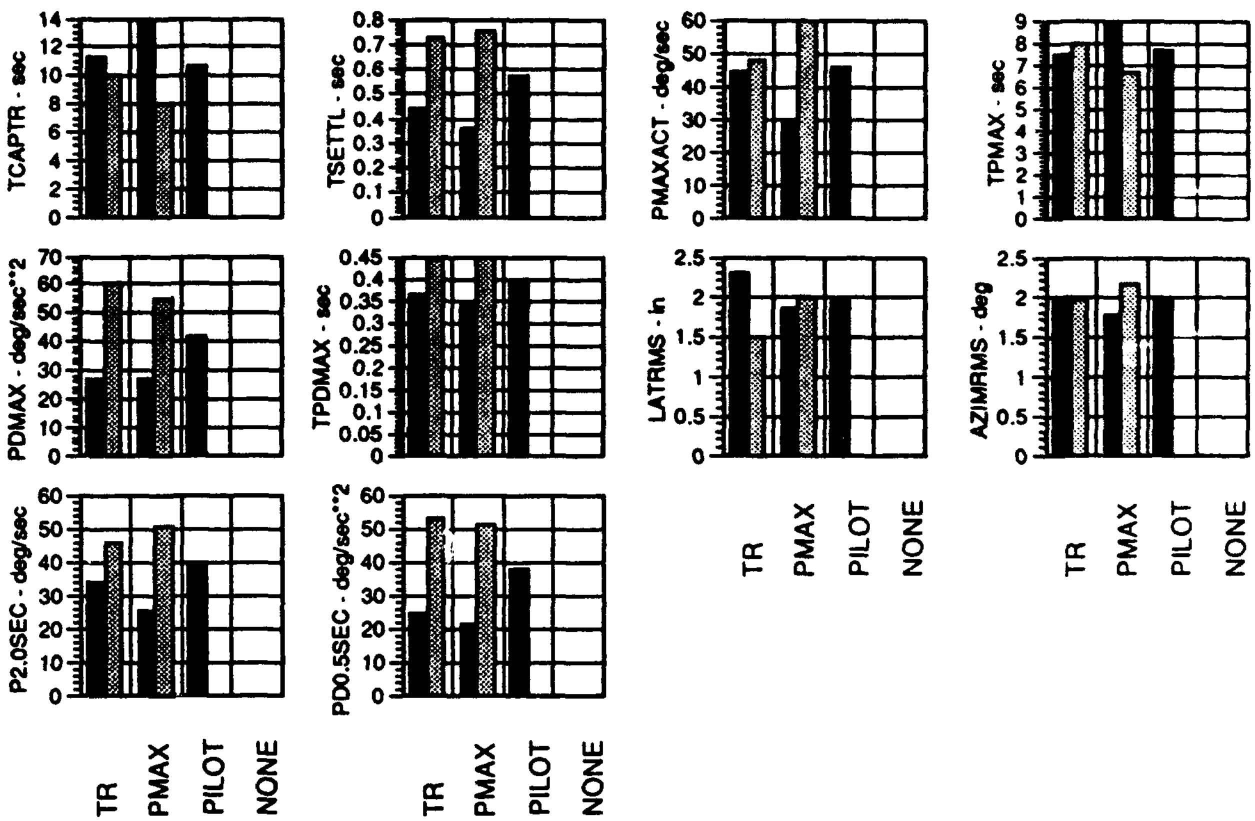
PMAX: Variations in maximum roll rate were implemented:
- (-) 30 deg/sec, Level 2
- (+) 60 deg/sec, Level 1

### Test Matrix

| Lon Config | Lat Config | TR | PMAX | PLT |
|---|---|---|---|---|
| | 209 | 0.6 (1) | 60 (1) | 6,8 |
| | 210 | 1.4 (0) | 60 (1) | 6,8 |
| | 211 | 0.6 (1) | 30 (0) | 6,8 |
| | 212 | 1.4 (0) | 30 (0) | 6,8 |

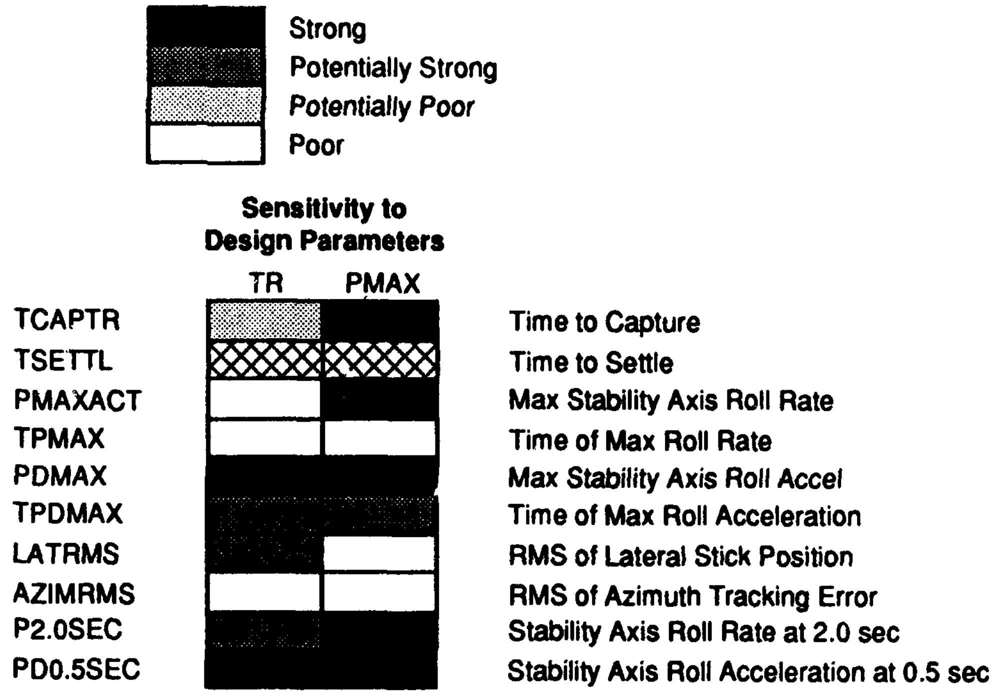
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25 | TCAPTR | 0.9999 | TR | 0.955 | 11.22 | 10.115 | 0 | 0 | -0.104 | #DIV/0! | 3 | | 3 |
| | | | PMAX | 1.000 | 14 | 7.9827 | 0 | 0 | -0.592 | #DIV/0! | 1 | | 1 |
| | | | PLT | -999.000 | 10.718 | 0 | 0 | 0 | 0.000 | | | | |
| 26 | TSETTL | 0.7273 | TR | 0.500 | 0.4417 | 0.73 | 0 | 0 | 0.524 | #DIV/0! | 4 | | 4 |
| | | | PMAX | 0.600 | 0.36 | 0.75 | 0 | 0 | 0.802 | #DIV/0! | 4 | | 4 |
| | | | PLT | -999.000 | 0.5727 | 0 | 0 | 0 | 0.000 | | | | |
| 30 | PMAXACT | 0.9999 | TR | 1.000 | 44.456 | 47.996 | 0 | 0 | 0.077 | #DIV/0! | 4 | | 4 |
| | | | PMAX | 1.000 | 29.619 | 59.771 | 0 | 0 | 0.761 | #DIV/0! | 1 | | 1 |
| | | | PLT | -999.000 | 46.066 | 0 | 0 | 0 | 0.000 | | | | |
| 31 | TPMAX | 0.5331 | TR | 0.252 | 7.4371 | 7.9546 | 0 | 0 | 0.067 | #DIV/0! | 4 | | 4 |
| | | | PMAX | 0.800 | 8.8298 | 6.7077 | 0 | 0 | -0.278 | #DIV/0! | 4 | | 4 |
| | | | PLT | -999.000 | 7.6723 | 0 | 0 | 0 | 0.000 | | | | |
| 32 | PDMAX | 0.9999 | TR | 1.000 | 27.034 | 60.122 | 0 | 0 | 0.887 | #DIV/0! | 1 | | 1 |
| | | | PMAX | 1.000 | 26.698 | 54.888 | 0 | 0 | 0.785 | #DIV/0! | 1 | | 1 |
| | | | PLT | -999.000 | 42.074 | 0 | 0 | 0 | 0.000 | | | | |
| 33 | TPDMAX | 0.947 | TR | 0.920 | 0.3621 | 0.4446 | 0 | 0 | 0.207 | #DIV/0! | 2 | | 2 |
| | | | PMAX | 0.961 | 0.3398 | 0.4494 | 0 | 0 | 0.283 | #DIV/0! | 2 | | 2 |
| | | | PLT | -999.000 | 0.3996 | 0 | 0 | 0 | 0.000 | | | | |
| 43 | LATRMS | 0.7509 | TR | 0.888 | 2.2996 | 1.4764 | 0 | 0 | -0.458 | #DIV/0! | 2 | | 2 |
| | | | PMAX | 0.348 | 1.8544 | 1.9845 | 0 | 0 | 0.068 | #DIV/0! | 4 | | 4 |
| | | | PLT | -999.000 | 1.9254 | 0 | 0 | 0 | 0.000 | | | | |
| 45 | AZIMRMS | 0.3789 | TR | 0.033 | 1.9889 | 1.9756 | 0 | 0 | -0.007 | #DIV/0! | 4 | | 4 |
| | | | PMAX | 0.734 | 1.7784 | 2.1533 | 0 | 0 | 0.192 | #DIV/0! | 4 | | 4 |
| | | | PLT | -999.000 | 1.9829 | 0 | 0 | 0 | 0.000 | | | | |
| 46 | PXSEC | 0.9999 | TR | 1.000 | 33.469 | 45.474 | 0 | 0 | 0.311 | #DIV/0! | 2 | | 2 |
| | (2.0 sec) | | PMAX | 1.000 | 25.026 | 50.509 | 0 | 0 | 0.761 | #DIV/0! | 1 | | 1 |
| | | | PLT | -999.000 | 38.926 | 0 | 0 | 0 | 0.000 | | | | |
| 47 | PDXSEC | 0.9999 | TR | 1.000 | 24.705 | 52.921 | 0 | 0 | 0.838 | #DIV/0! | 1 | | 1 |
| | (0.5 sec) | | PMAX | 1.000 | 21.316 | 51.043 | 0 | 0 | 0.988 | #DIV/0! | 1 | | 1 |
| | | | PLT | -999.000 | 37.531 | 0 | 0 | 0 | 0.000 | | | | |

STEM 13



TCAPTR - sec
TSETTL - sec
PMAXACT - deg/sec
TPMAX - sec
PDMAX - deg/sec**2
TPDMAX - sec
LATRMS - in
AZIMRMS - deg
P2.0SEC - deg/sec
PD0.5SEC - deg/sec**2
TR
PMAX
PILOT
NONE

STEM 13




Note: Data available for only a single pilot, therefore, sensitivity to pilot variability and overall sensitivity not shown.

STEM 13
PILOT H
LONGITUDINAL CONFIGURATION 304
LATERAL CONFIGURATION 209
CHR 4

Is it satisfactory without improvement? It is close to being satisfactory without improvement. But I will say that desired performance requires moderate pilot compensation. The roll rate is good. It has a fairly quick response to opposite lateral control inputs. But it is still a bit sensitive on the capture. Out of all the ones we've flown so far I like that one the best but I don't think it's satisfactory without improvement. The roll rate is great and when I put the lateral stick in it's great. But I still get that one overshoot that I'm not really expecting and I kind of overcontrol that, so at that point I feel that it's kind of flying itself. I am using a high gain technique to try to use full stick as long as possible.

STEM 13
PILOT H
LONGITUDINAL CONFIGURATION 304
LATERAL CONFIGURATION 209
CHR 3

Is it controllable? Yes. Is adequate performance attainable? Yes. Is it satisfactory without improvement? Yes. I am compensating a little bit when trying to track it laterally. But I don't have a problem at all in pitch, so overall minimal pilot compensation required.

STEM 13
PILOT H
LONGITUDINAL CONFIGURATION 304
LATERAL CONFIGURATION 210
CHR 5

Pretty zippy. High sustained roll rate there. I am going to have to lead that one a lot more. It's controllable. Adequate performance is attainable. Is it satisfactory without improvement? No. Deficiencies warrant improvement. I like the fast roll rate of the airplane. The only problem was that I had to compensate quite a bit to get that capture working. Most of the time I had two overshoots. I had to lead it by about thirty degrees and hold in opposite full lateral stick. Moderately objectionable deficiencies with considerable pilot compensation. The primary deficiency is a lack of response to the opposite roll control.

STEM 13
PILOT H
LONGITUDINAL CONFIGURATION 304
LATERAL CONFIGURATION 211
CHR 4

That seemed to have a slower roll rate (as Lateral configuration 212) but when I go to stop it I get a much more immediate response and the aircraft stops quicker which is nice. Much nicer control on this stop. The yaw rate or the roll rate is fairly slow but the response is much better when

I'm trying to capture it so I don't have to lead it hardly at all. When I put in the opposite lateral control it responds immediately and I like that. So I have the capture part down. It is controllable and adequate performance is attainable. Desired performance requires moderate pilot compensation and it has minor but annoying deficiencies. It has kind of a slow roll rate. I like this one better than the last one (Lateral configuration 212). The yaw rate was not real zippy, but the response is real good for the capture part of it. I did not have to lead the capture much at all. And I did not have to hold the control input in very long before I got a response. It probably required about a quarter stick cross check.

STEM 13
PILOT H
LONGITUDINAL CONFIGURATION 304
LATERAL CONFIGURATION 212
CHR 5

I'm having to use full opposite stick at about 20 degrees prior to getting there and then it's very slow to respond to that. Then I've got to bring it right back in the opposite direction and stop myself. So it definitely requires lots of compensation and it's very slow. Is it controllable? Yes. Is adequate performance attainable? Yes. Is it satisfactory without improvement? No. Deficiencies warrant improvement. I'm going to call that performance adequate partially because it was very slow and mainly because when I put in the opposite stick nothing happened for a couple potatoes. I'm going to call that moderately objectionable deficiencies due to the lack of the roll response once you get the roll rate going and considerable pilot compensation.

STEM 13
PILOT H
LONGITUDINAL CONFIGURATION 717
LATERAL CONFIGURATION 209
CHR 3

Once I get him in the circle it's much easier to track him. That first reversal is a little bit more difficult. The gross acquisition part of it is a little bit harder because when I stop moving the stick and go to push forward there's a delay there before it goes where I want. I'm getting the nose around faster. Once I get him in there with this system it seems to be easy to track him. The gross acquisition just seems a little bit harder. Is it controllable? Yes. Is adequate performance attainable? Yes. Is it satisfactory without improvement? Yes. The compensation is just during the initial gross acquisition. I'm easing off of the stick earlier before I get the circle to him and the rate catches up with it I guess and it seemed to stay on there. So I'm compensating in pitch but once I get him in the circle, the tracking part is much easier. It seems real good. So I am compensating.

STEM 13
PILOT H
LONGITUDINAL CONFIGURATION 726
LATERAL CONFIGURATION 209
CHR 6

Jiminy Christmas. I can't push down on the stick. Wow. I don't like that one at all. It wasn't responsive to my inputs. It seemed a little bit squirellier in pitch, that's for sure. It doesn't look like I have the pitch nose down control. The nose wants to hang up. It seems a little bit slower but it seems to pull okay. See I'm using full forward stick to stop and nothing is happening. Then I overshoot it. When I pull back easily I can get him in there. Laterally it seems okay. Is it controllable? Yes. Is adequate performance attainable? Yes. Is it satisfactory without improvement? No. I got desired performance. I don't like that problem with forward stick and to me that was very objectionable. So although I got desired performance, there is definitely going to be extensive pilot compensation mainly in the gross acquisition part. Once I got him in the ballpark I was able to track him okay but the gross acquisition was the worse part.

## Data Contents for STEM 16: 1-g Stabilized Pushover

TEST 1: Maneuver tested at 50° AOA, V≈100 kt
- Summary of Design Parameter Variations Tested
- Numerical Summary of Statistical Analysis
- Bar Graphs of Measures of Merit
- Design Parameter Correlations, Pilot Variability, and Overall Correlations
- Pilot Comments

TEST 2: Maneuver tested at 50° AOA, V≈100 kt, different design parameters than TEST 1
- Summary of Design Parameter Variations Tested

The following information is repeated for Analyses A, B, and C
- Numerical Summary of Statistical Analysis

The following information is located after Analyses A, B, and C
- Bar Graphs of Measures of Merit

The following information is repeated for Analyses A, B, and C
- Design Parameter Correlations, Pilot Variability, and Overall Correlations

The following information is located after Analyses A, B, and C
- Pilot Comments

Several statistical analyses are included to test multiple variations on center of gravity location. If only one analysis is of interest, then Analysis A should be used. The following is a list of the analyses included for STEM 16 TEST 2:

| | |
|---|---|
| A | Comparison between CG positions of -3.46% to 0.0% |
| B | Comparison between CG positions of -3.46% to 2.77% |
| C | Comparison between CG positions of -3.46% to 4.50% |

## Summary of Design Parameters Tested for STEM 16 TEST 1

Test variables:

TV: Controls whether or not pitch thrust vectoring was enabled:

(-) No vectoring, results in the pitch rate system being AOA limited

(+) With vectoring

THETA: Indicates the pitch attitude that the nose-down recovered was initiated from. This was tested to achieve a variation on airspeed:

(-) 35°, higher airspeed

(+) 60°, lower airspeed

### Test Matrix

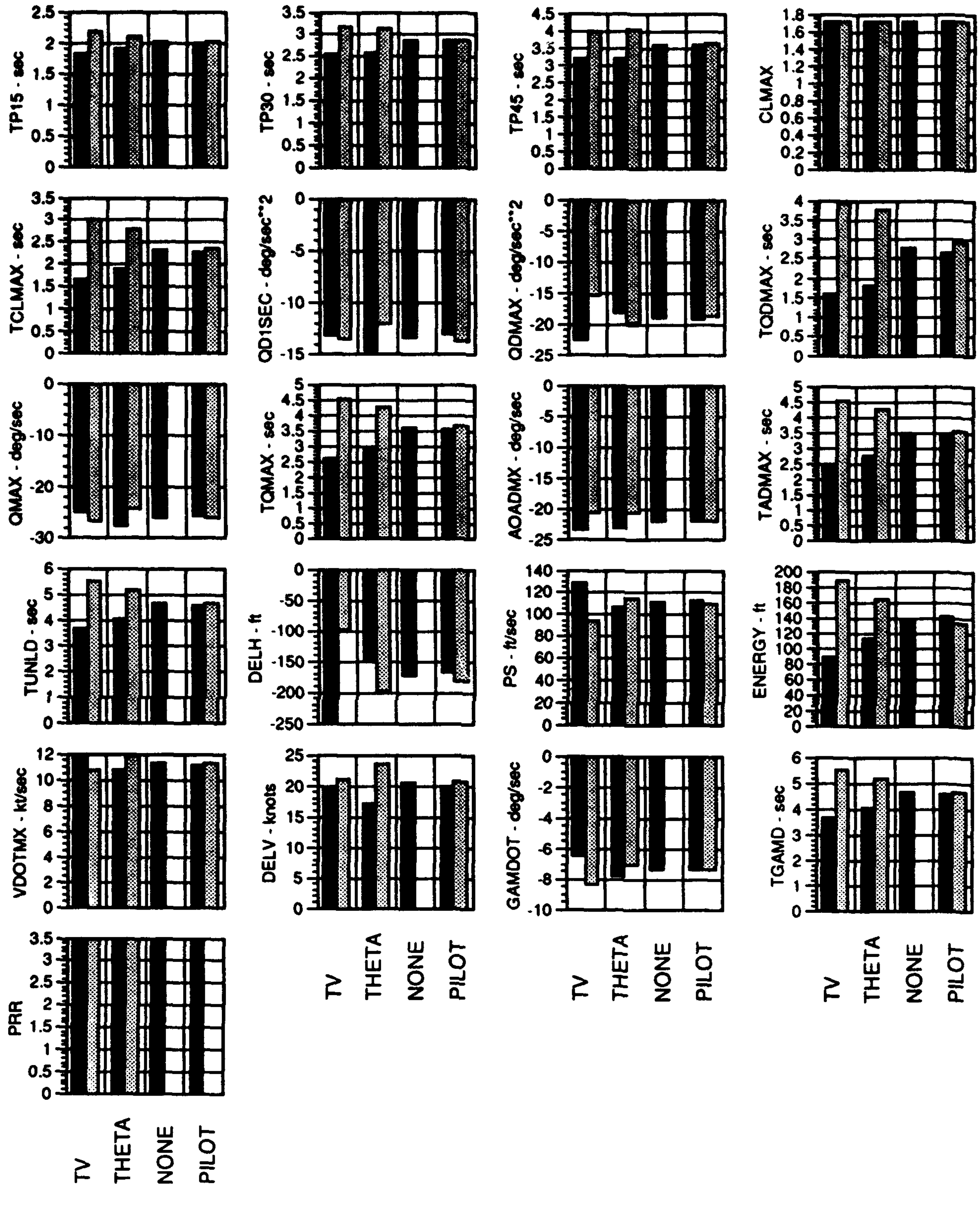
| Lon Config | Lat Config | TV | THETA |
|---|---|---|---|
| 121 | 11 | On (+) | 35° (-) |
| 122 | 11 | Off (-) | 35° (-) |
| 111 | 11 | On (+) | 60° (+) |
| 123 | 11 | Off (-) | 60° (+) |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ### | TP15 | 0.2631 | TV | 0.827 | 1.8255 | 2.1852 | 0 | 0 | 0.181 | 13.78 | 4 | 1 | 4 |
| | | | THETA | 0.536 | 1.9106 | 2.1001 | 0 | 0 | 0.095 | 7.21 | 4 | 1 | 4 |
| | | | PLT | 0.082 | 1.9922 | 2.0185 | 0 | 0 | 0.013 | | | | |
| ### | TP30 | 0.5873 | TV | 0.896 | 2.5463 | 3.1852 | 0 | 0 | 0.226 | 29.21 | 3 | 1 | 3 |
| | | | THETA | 0.849 | 2.5856 | 3.1459 | 0 | 0 | 0.197 | 25.54 | 4 | 1 | 4 |
| | | | PLT | 0.047 | 2.8547 | 2.8768 | 0 | 0 | 0.008 | | | | |
| ### | TP45 | 0.7446 | TV | 0.915 | 3.2047 | 3.981 | 0 | 0 | 0.219 | 29.84 | 2 | 1 | 2 |
| | | | THETA | 0.933 | 3.1773 | 4.0084 | 0 | 0 | 0.234 | 32.01 | 2 | 1 | 2 |
| | | | PLT | 0.049 | 3.5797 | 3.606 | 0 | 0 | 0.007 | | | | |
| 2 | CLMAX | 0.4965 | TV | 0.602 | 1.7187 | 1.7193 | 0 | 0 | 0.000 | 1.08 | 4 | 2 | 4 |
| | | | THETA | 0.880 | 1.7195 | 1.7184 | 0 | 0 | -0.001 | 2.06 | 4 | 1 | 4 |
| | | | PLT | 0.570 | 1.7187 | 1.7192 | 0 | 0 | 0.000 | | | | |
| 3 | TCLMAX | 0.9768 | TV | 0.997 | 1.6463 | 3.0102 | 0 | 0 | 0.641 | 18.53 | 1 | 1 | 1 |
| | | | THETA | 0.964 | 1.8814 | 2.7751 | 0 | 0 | 0.398 | 11.52 | 2 | 1 | 2 |
| | | | PLT | 0.160 | 2.288 | 2.3685 | 0 | 0 | 0.035 | | | | |
| ### | QD1SEC | 0.0112 | TV | 0.090 | -13.164 | -13.622 | 0 | 0 | -0.034 | 0.88 | 4 | 3 | 4 |
| | | | THETA | 0.476 | -14.697 | -12.089 | 0 | 0 | 0.197 | 5.03 | 4 | 1 | 4 |
| | | | PLT | 0.102 | -13.131 | -13.655 | 0 | 0 | -0.039 | | | | |
| 6 | QDMAX | 0.1361 | TV | 0.792 | -22.518 | -15.478 | 0 | 0 | 0.384 | 16.63 | 4 | 1 | 4 |
| | | | THETA | 0.270 | -18.053 | -19.943 | 0 | 0 | -0.100 | 4.32 | 4 | 1 | 4 |
| | | | PLT | 0.064 | -19.217 | -18.779 | 0 | 0 | 0.023 | | | | |
| 7 | TQDMAX | 0.9378 | TV | 0.987 | 1.6005 | 3.956 | 0 | 0 | 1.034 | 11.22 | 1 | 1 | 1 |
| | | | THETA | 0.966 | 1.7981 | 3.7584 | 0 | 0 | 0.806 | 8.75 | 1 | 1 | 1 |
| | | | PLT | 0.231 | 2.6505 | 2.906 | 0 | 0 | 0.092 | | | | |
| 8 | QMAX | 0.9999 | TV | 1.000 | -25.255 | -26.917 | 0 | 0 | -0.064 | 5.63 | 4 | 1 | 4 |
| | | | THETA | 1.000 | -27.67 | -24.503 | 0 | 0 | 0.122 | 10.77 | 3 | 1 | 3 |
| | | | PLT | 0.821 | -25.939 | -26.234 | 0 | 0 | -0.011 | | | | |
| 9 | TQMAX | 0.7428 | TV | 0.960 | 2.6047 | 4.5644 | 0 | 0 | 0.591 | 20.90 | 1 | 1 | 1 |
| | | | THETA | 0.852 | 2.9148 | 4.2542 | 0 | 0 | 0.387 | 13.70 | 3 | 1 | 3 |
| | | | PLT | 0.090 | 3.5339 | 3.6352 | 0 | 0 | 0.028 | | | | |
| 11 | AOADMX | 0.9907 | TV | 0.997 | -23.351 | -20.577 | 0 | 0 | 0.127 | 69.27 | 3 | 1 | 3 |
| | | | THETA | 0.993 | -23.174 | -20.754 | 0 | 0 | 0.111 | 60.38 | 3 | 1 | 3 |
| | | | PLT | 0.040 | -21.984 | -21.944 | 0 | 0 | 0.002 | | | | |
| 12 | TADMAX | 0.8328 | TV | 0.974 | 2.4338 | 4.531 | 0 | 0 | 0.662 | 18.88 | 1 | 1 | 1 |
| | | | THETA | 0.897 | 2.7398 | 4.2251 | 0 | 0 | 0.447 | 12.74 | 2 | 1 | 2 |
| | | | PLT | 0.111 | 3.4214 | 3.5435 | 0 | 0 | 0.035 | | | | |
| ### | TUNLD | 0.9924 | TV | 0.999 | 3.6713 | 5.5394 | 0 | 0 | 0.423 | 37.96 | 1 | 1 | 1 |
| | | | THETA | 0.979 | 4.0148 | 5.1959 | 0 | 0 | 0.261 | 23.40 | 2 | 1 | 2 |
| | | | PLT | 0.087 | 4.5797 | 4.631 | 0 | 0 | 0.011 | | | | |
| ### | DELH | 0.9999 | TV | 1.000 | -249.53 | -98.958 | 0 | 0 | 1.062 | 11.87 | 1 | 1 | 1 |
| | | | THETA | 0.945 | -150.78 | -197.7 | 0 | 0 | -0.274 | 3.06 | 2 | 1 | 2 |
| | | | PLT | 0.496 | -166.46 | -182.03 | 0 | 0 | -0.090 | | | | |
| 36 | PS | 0.9999 | TV | 1.000 | 128.34 | 94.154 | 0 | 0 | -0.315 | 13.38 | 2 | 1 | 2 |
| | | | THETA | 0.999 | 107.31 | 115.18 | 0 | 0 | 0.071 | 3.01 | 4 | 1 | 4 |
| | | | PLT | 0.793 | 112.56 | 109.94 | 0 | 0 | -0.024 | | | | |
| 37 | ENERGY | 0.9999 | TV | 1.000 | 87.225 | 187.22 | 0 | 0 | 0.840 | 12.44 | 1 | 1 | 1 |
| | | | THETA | 1.000 | 111.75 | 162.69 | 0 | 0 | 0.384 | 5.69 | 2 | 1 | 2 |
| | | | PLT | 0.991 | 141.85 | 132.59 | 0 | 0 | -0.068 | | | | |
| 38 | VDOTMX | 0.9999 | TV | 1.000 | 11.842 | 10.697 | 0 | 0 | -0.102 | 7.69 | 3 | 1 | 3 |
| | | | THETA | 1.000 | 10.702 | 11.837 | 0 | 0 | 0.101 | 7.62 | 3 | 1 | 3 |
| | | | PLT | 0.523 | 11.195 | 11.344 | 0 | 0 | 0.013 | | | | |
| 39 | DELV | 0.9761 | TV | 0.612 | 19.62 | 21.032 | 0 | 0 | 0.070 | 1.83 | 4 | 2 | 4 |
| | | | THETA | 0.999 | 17.124 | 23.529 | 0 | 0 | 0.323 | 8.51 | 2 | 1 | 2 |
| | | | PLT | 0.365 | 19.941 | 20.712 | 0 | 0 | 0.038 | | | | |

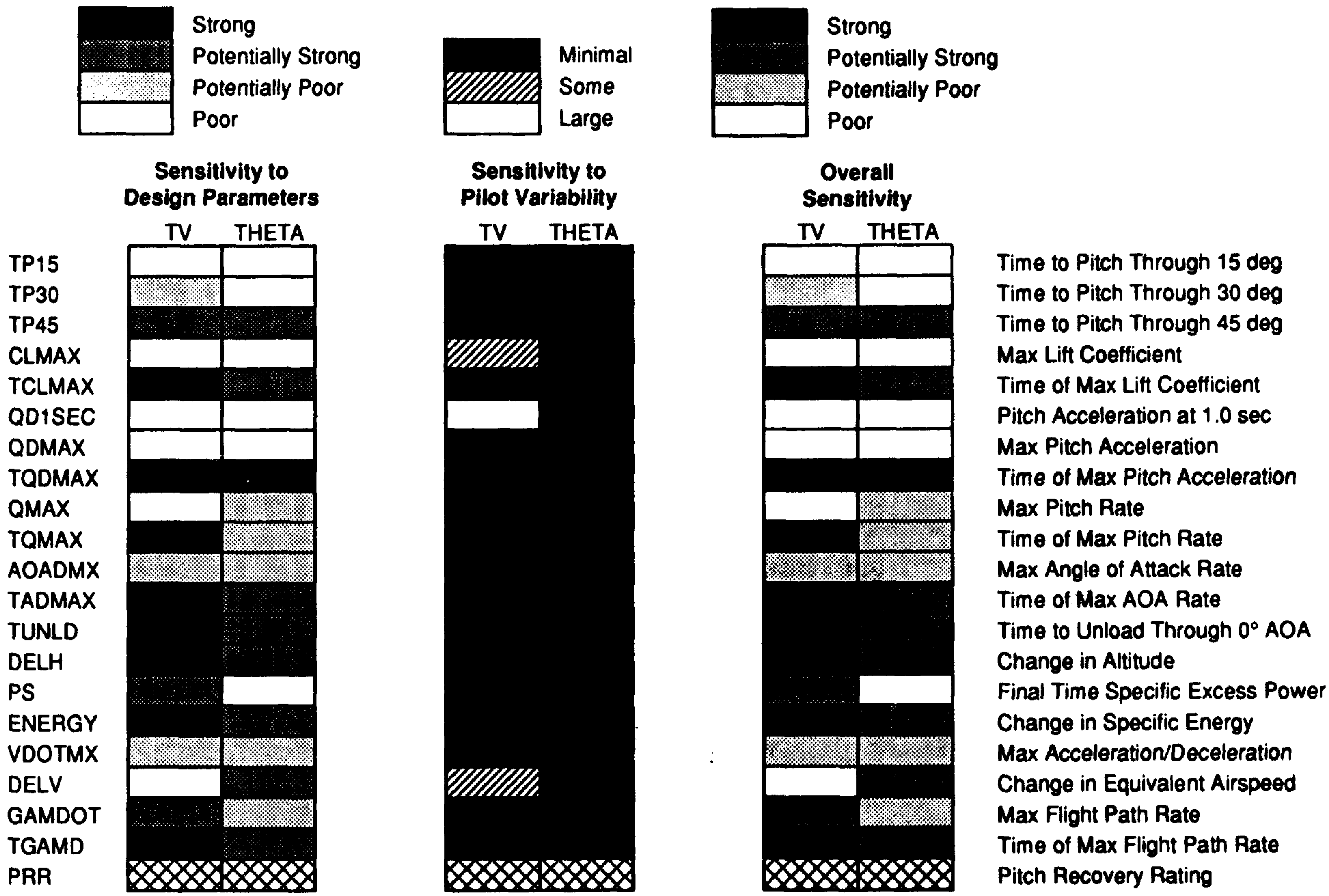
STEM 16 TEST 1

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 40 | GAMDOT | 0.9999 | TV | 1.000 | -6.4424 | -8.4127 | 0 | 0 | -0.270 | 315.84 | 2 | 1 | 2 |
| | | | THETA | 1.000 | -7.857 | -6.9982 | 0 | 0 | 0.116 | 135.70 | 3 | 1 | 3 |
| | | | PLT | 0.026 | -7.4308 | -7.4244 | 0 | 0 | 0.001 | | | | |
| 41 | TGAMD | 0.9924 | TV | 0.999 | 3.6713 | 5.5394 | 0 | 0 | 0.423 | 37.96 | 1 | 1 | 1 |
| | | | THETA | 0.979 | 4.0148 | 5.1959 | 0 | 0 | 0.261 | 23.40 | 2 | 1 | 2 |
| | | | PLT | 0.087 | 4.5797 | 4.631 | 0 | 0 | 0.011 | | | | |
| 50 | PRR | 0 | TV | 0.000 | 3.5 | 3.5 | 0 | 0 | 0.000 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | THETA | 0.000 | 3.5 | 3.5 | 0 | 0 | 0.000 | #DIV/0! | 4 | #DIV/0! | #DIV/0! |
| | | | PLT | -999.000 | 3.5 | | 0 | 0 | 0.000 | | | | |

STEM 16 TEST 1



STEM 16 TEST 1



STEM 16 TEST 1 theta=35, alpha=50
PILOT A
LONGITUDINAL CONFIGURATION 121
LATERAL CONFIGURATION 11
PRR 3

Thats not bad. The final rate is a little sluggish. The initial acceleration was okay but it capped itself too early. The acceleration looks good but its got a governor on it that stops it at too low a rate. I had a little bit of positive pitch rate at the moment of inputting forward stick which will color the data on that one so I wish you'd do at least 1 extra data run. It'll really mess up some of your measures of your merit if I have a positive pitch rate at the time of input there. At least it sure did for our test. Its not bad. Either we run out of control surface or flight control flexibility or something but its just not giving me the kind of pitch rate I would expect at full forward stick on an airplane. Feels like you're on some kind of limiter. Pitch Recover Rating: Was there enough pitch response? There was not really enough. Acceleration was good, rate was too slow. I could use more rate. Was time to recover short enough? It should have been a little quicker because of the rate. Was recovery in question? No. Pilot compensation required? No. Response suitable for the mission? Yes, it was probably suitable but it would be better if we got to a higher rate. Is recovery adequate? Yes it is adequate, it is not highly desirable. Nose pitch control margin is satisfactory but it does degrade the mission slightly because the final pitch rate is too low.

STEM 16 TEST 1 theta=35, alpha=50
PILOT E
LONGITUDINAL CONFIGURATION 121
LATERAL CONFIGURATION 11

No comments.

STEM 16 TEST 1 theta=35, alpha=50
PILOT A
LONGITUDINAL CONFIGURATION 122
LATERAL CONFIGURATION 11
PRR 4

The response time lag is very good. I immediately get a response, but the acceleration is too slow. It takes too long to get the final rate and the rate isn't desirable until my nose is way down. I kind of rate these things on the number of times I curse the airplane. If the response is sluggish enough that I have time to start thinking about why my airplane isn't doing what I'm asking it, then its a degrading factor. If it is giving a response where it is clear that it has reached a good rate and I no longer have to worry about it then thats an enhancing factor. Pitch Recovery Rating: Was there enough pitch response? No. The acceleration was too slow. Final rate was good. Could I use more response? Yes. Time to recover short enough? No. Over this amount of pitch range its gotta go faster than that. Was recovery in question? No. Pilot compensation required? No. Response suitable for the mission? No. So is recovery adequate? No. Recovery was not in doubt but it was marginal. It moderately degrades mission and/or safety. This is a 4 because it is too sluggish an acceleration rate. You ram it forward and you have to curse

the airplane as it slowly ramps up to its rate. It took until I was 20 nose low before I got to the kind of pitch rate I'd want to see out of the airplane for a full forward stick input.

STEM 16 TEST 1 theta=35, alpha=50
PILOT E
LONGITUDINAL CONFIGURATION 122
LATERAL CONFIGURATION 11

That one is real sluggish. Much more than the other one (longitudinal configuration 121). Real slow initial pitch rate on that one compared to the first one. Real slow in pitch.

STEM 16 TEST 1 theta=60, alpha=50
PILOT A
LONGITUDINAL CONFIGURATION 111
LATERAL CONFIGURATION 11
PRR 3

This aircraft is easier to hold a precise pitch attitude (than configuration 123), the other one was constantly bouncing about 1 degree. Nice final rate. Initial acceleration is a little better, a little snappier, airplane comes down. It doesn't feel so much like a dump truck. A little bit of a time lag. There, I ram it full forward, I don't see much response at all out of my pitch. I'm sure we're breaking alpha and the control surfaces are moving but I don't see a lot of good pitch response until about a second after I ram it in and then I get very nice acceleration and pitch response out of the airplane. Pitch Recover Rating scale: Was there enough pitch response? Yes, the acceleration was good, the rate was very good but it seemed there was a little bit of a time lag between full forward stick and the onset of the detectable accleration. Could I use more response? The acceleration and rate were good but I would be happier if you didn't have any visible time lag. Was the time to recover short enough? Yes. Was recovery in question? No. Was pilot compensation required? No. Is the response suitable for the mission? In this case I would say yes its suitable for the mission but it has some degrading tendencies. Is recovery adequate? Yes. Is it highly desirable? No. The recovery degrades the mission slightly because theres just a little bit of a time lag. But from that nose high to get the nose down that low you got immediate response. You have a good feeling that your airplane was recovering, the time is quick under the threat scenario that I'm looking at. This is the type of response I would like out of the aircraft except for that slightly degrading initial time lag.

STEM 16 TEST 1 theta=60, alpha=50
PILOT E
LONGITUDINAL CONFIGURATION 111
LATERAL CONFIGURATION 11

I wasn't able to quite hold it, I had a little bit of a downward pitch at the critical time there when I was approaching 50 and couldn't get the nose back up. Its real tight, 50 degrees must be real critical for this configuration. We are ending up at 59, or 58 degrees of pitch attitude when I have to start the unload.

STEM 16 TEST 1 theta=60, alpha=50
PILOT A
LONGITUDINAL CONFIGURATION 123
LATERAL CONFIGURATION 11
PRR 4

The airplane is a little bit hard to hold here. Initial rate is sluggish, final rate is good. I'd be happier if the nose would come down sooner. I really feel like a grape up there, waiting for the nose to come back down. It is the initial pitch response I'm not liking for this kind of threat situation. Pitch Recovery scale: Was there enough pitch response? No. The initial acceleration is too slow, you ram it full forward and it just slowly starts dropping the nose. The final rate is good. Could I use more response? Yes. I would wish would get to my final rate quicker. Was the time to recover short enough? Not really. By the time I got my nose down and I'm starting to accelerate here, just about any airplane could have converted over the top and come down at me. Was recovery in question - almost - you ram the stick full forward and its sluggish enough that if you were looking at a bogie you'd be worried about it. Was pilot compensation required? No. Is the response suitable for the mission? For this particular mission no. You need to get an airplane that comes down quicker than that. Is the aircraft recoverable? Yes. Is recovery adequate? I would say no. More pitch down is required. Recovery was not in doubt but it was marginal, moderately degrades mission or safety would be a 4, so this is a Pitch Recovery Rating scale 4.

STEM 16 TEST 1 theta=60, alpha=50
PILOT E
LONGITUDINAL CONFIGURATION 123
LATERAL CONFIGURATION 11

Much more sluggish. Acceleration is probably better in this configuration but its more sluggish in pitch.

**Summary of Design Parameters Tested for STEM 16 TEST 2**

Test variables:
DCG: Indicates variations in center of gravity location in %MAC. Four values were tested:
- -3.46% (forward of nominal)
- 0.0% (nominal)
- 2.77% (aft of nominal)
- 4.50% (aft of nominal)

**Test Matrix (Pilots A,F)**

| Lon Config | Lat Config | DCG |
|---|---|---|
| 145 | 2 | -3.46% |
| 146 | 2 | 0.0% |
| 147 | 2 | 2.77% |
| 148 | 2 | 4.50% |

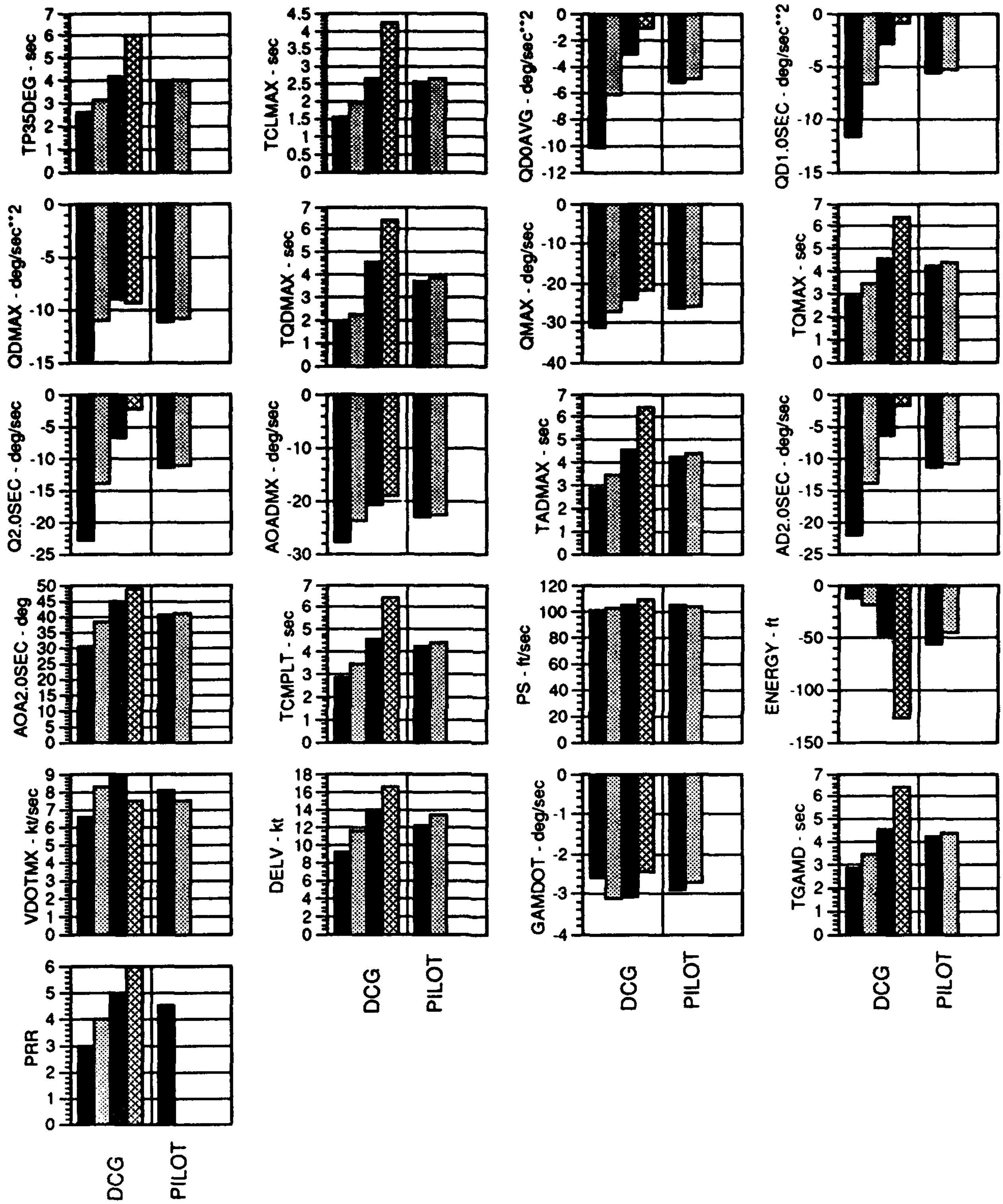
STEM 16 TEST 2 ANALYSIS A

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | TPXDEG | 0.9999 | DCG | 1.000 | 2.5833 | 3.1549 | 4.1949 | 6.0612 | 0.201 | 10.13 | 2 | 1 | 2 |
| | (35 deg) | | PLT | 0.984 | 3.9589 | 4.0383 | 0 | 0 | 0.020 | | | | |
| 3 | TCLMAX | 0.9999 | DCG | 1.000 | 1.5423 | 1.9172 | 2.654 | 4.2334 | 0.219 | 6.18 | 2 | 1 | 2 |
| | | | PLT | 0.982 | 2.5408 | 2.6326 | 0 | 0 | 0.035 | | | | |
| 4 | QD0AVG | 0.9999 | DCG | 1.000 | -10.131 | -6.1362 | -3.1655 | -1.1568 | 0.523 | 9.21 | 1 | 1 | 1 |
| | (1.0 sec) | | PLT | 0.987 | -5.2935 | -5.0014 | 0 | 0 | 0.057 | | | | |
| 5 | QDXSEC | 0.9999 | DCG | 1.000 | -11.65 | -6.6924 | -2.8941 | -0.8822 | 0.583 | 9.02 | 1 | 1 | 1 |
| | (1.0 sec) | | PLT | 0.999 | -5.7083 | -5.3511 | 0 | 0 | 0.065 | | | | |
| 6 | QDMAX | 0.9999 | DCG | 1.000 | -14.716 | -11.058 | -9.0538 | -9.3146 | 0.290 | 9.54 | 2 | 1 | 2 |
| | | | PLT | 1.000 | -11.203 | -10.868 | 0 | 0 | 0.030 | | | | |
| 7 | TQDMAX | 0.9999 | DCG | 1.000 | 1.8046 | 2.2614 | 4.5474 | 6.4547 | 0.228 | 6.88 | 2 | 1 | 2 |
| | | | PLT | 0.995 | 3.7048 | 3.8293 | 0 | 0 | 0.033 | | | | |
| 8 | QMAX | 0.9999 | DCG | 1.000 | -31.273 | -27.163 | -24.004 | -22.094 | 0.141 | 22.44 | 3 | 1 | 3 |
| | | | PLT | 0.911 | -26.216 | -26.051 | 0 | 0 | 0.006 | | | | |
| 9 | TQMAX | 0.9999 | DCG | 1.000 | 2.8374 | 3.4827 | 4.5474 | 6.4547 | 0.206 | 6.53 | 2 | 1 | 2 |
| | | | PLT | 0.998 | 4.2622 | 4.3989 | 0 | 0 | 0.032 | | | | |
| 10 | QXSEC | 0.9999 | DCG | 1.000 | -22.767 | -13.952 | -6.7119 | -2.2375 | 0.510 | 18.53 | 1 | 1 | 1 |
| | (2.0 sec) | | PLT | 0.921 | -11.574 | -11.26 | 0 | 0 | 0.027 | | | | |
| 11 | AOADMX | 0.9999 | DCG | 1.000 | -27.697 | -23.79 | -20.849 | -19.162 | 0.153 | 10.77 | 3 | 1 | 3 |
| | | | PLT | 0.998 | -23.037 | -22.712 | 0 | 0 | 0.014 | | | | |
| 12 | TADMAX | 0.9999 | DCG | 1.000 | 2.8374 | 3.4827 | 4.5474 | 6.4547 | 0.206 | 6.53 | 2 | 1 | 2 |
| | | | PLT | 0.998 | 4.2622 | 4.3989 | 0 | 0 | 0.032 | | | | |
| 13 | ADXSEC | 0.9999 | DCG | 1.000 | -22.176 | -13.922 | -6.5743 | -1.8887 | 0.483 | 10.83 | 1 | 1 | 1 |
| | (2.0 sec) | | PLT | 0.986 | -11.388 | -10.892 | 0 | 0 | 0.045 | | | | |
| 22 | AOAXSEC | 0.9999 | DCG | 1.000 | 30.269 | 38.193 | 44.682 | 48.726 | 0.235 | 13.01 | 2 | 1 | 2 |
| | (2.0 sec) | | PLT | 0.990 | 40.103 | 40.833 | 0 | 0 | 0.018 | | | | |
| 27 | TCMPLT | 0.9999 | DCG | 1.000 | 2.8374 | 3.4827 | 4.5474 | 6.4547 | 0.206 | 6.53 | 2 | 1 | 2 |
| | | | PLT | 0.998 | 4.2622 | 4.3989 | 0 | 0 | 0.032 | | | | |
| 36 | PS | 0.9999 | DCG | 1.000 | 101.04 | 102.27 | 105.09 | 108.36 | 0.012 | 0.96 | 4 | 3 | 4 |
| | | | PLT | 0.987 | 104.85 | 103.53 | 0 | 0 | -0.013 | | | | |
| 37 | ENERGY | 0.9999 | DCG | 1.000 | -12.595 | -18.215 | -47.011 | -127.67 | -0.377 | 1.82 | 2 | 2 | 3 |
| | | | PLT | 0.997 | -56.651 | -46.094 | 0 | 0 | 0.208 | | | | |
| 38 | VDOTMX | 0.9588 | DCG | 0.898 | 6.58 | 8.2187 | 8.9359 | 7.4474 | 0.224 | 3.02 | 3 | 1 | 3 |
| | | | PLT | 0.613 | 8.0842 | 7.5068 | 0 | 0 | -0.074 | | | | |
| 39 | DELV | 0.9999 | DCG | 1.000 | 9.1754 | 11.442 | 14.02 | 16.513 | 0.223 | 2.46 | 2 | 1 | 2 |
| | | | PLT | 1.000 | 12.21 | 13.365 | 0 | 0 | 0.090 | | | | |
| 40 | GAMDOT | 0.9579 | DCG | 0.819 | -2.5999 | -3.1137 | -3.0653 | -2.4799 | -0.181 | 2.99 | 4 | 1 | 4 |
| | | | PLT | 0.517 | -2.9 | -2.7294 | 0 | 0 | 0.061 | | | | |
| 41 | TGAMD | 0.9999 | DCG | 1.000 | 2.8292 | 3.4827 | 4.5392 | 6.4547 | 0.209 | 6.24 | 2 | 1 | 2 |
| | | | PLT | 0.998 | 4.254 | 4.3989 | 0 | 0 | 0.034 | | | | |
| 50 | PRR | 0 | DCG | ####### | 3 | 4 | 5 | 6 | 0.292 | 0.00 | 4 | 3 | 4 |
| | | | PLT | ####### | 4.5 | -999 | 0 | 0 | -112.002 | | | | |

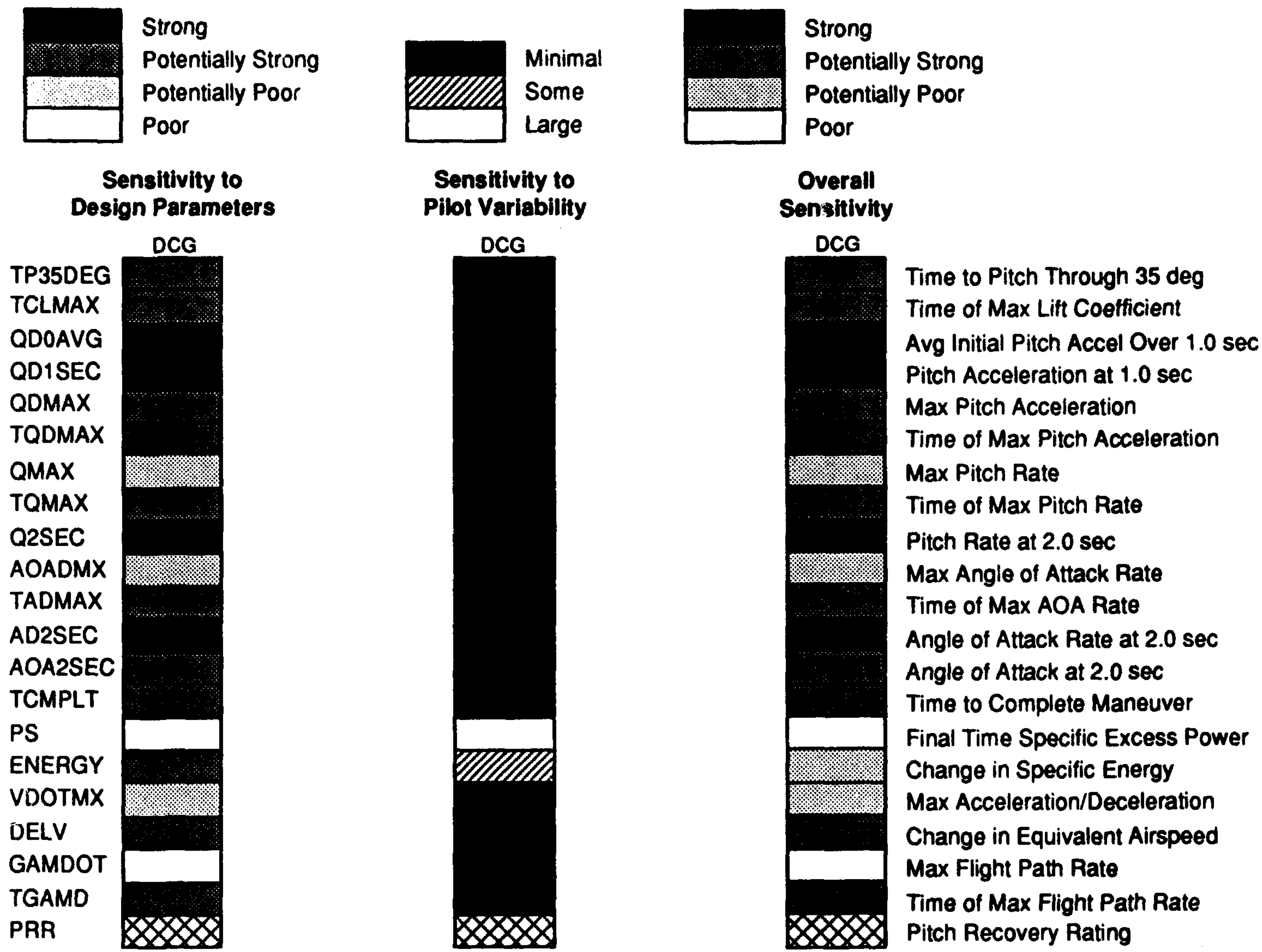
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | TPXDEG | 0.9999 | DCG | 1.000 | 2.5833 | 3.1549 | 4.1949 | 6.0612 | 0.504 | 25.37 | 1 | 1 | 1 |
| | (35 deg) | | PLT | 0.984 | 3.9589 | 4.0383 | 0 | 0 | 0.020 | | | | |
| 3 | TCLMAX | 0.9999 | DCG | 1.000 | 1.5423 | 1.9172 | 2.654 | 4.2334 | 0.570 | 16.07 | 1 | 1 | 1 |
| | | | PLT | 0.982 | 2.5408 | 2.6326 | 0 | 0 | 0.035 | | | | |
| 4 | QD0AVG | 0.9999 | DCG | 1.000 | -10.13 | -6.136 | -3.166 | -1.157 | 1.444 | 25.43 | 1 | 1 | 1 |
| | (1.0 sec) | | PLT | 0.987 | -5.293 | -5.001 | 0 | 0 | 0.057 | | | | |
| 5 | QDXSEC | 0.9999 | DCG | 1.000 | -11.65 | -6.692 | -2.894 | -0.882 | 1.889 | 29.20 | 1 | 1 | 1 |
| | (1.0 sec) | | PLT | 0.999 | -5.708 | -5.351 | 0 | 0 | 0.065 | | | | |
| 6 | QDMAX | 0.9999 | DCG | 1.000 | -14.72 | -11.06 | -9.054 | -9.315 | 0.505 | 16.63 | 1 | 1 | 1 |
| | | | PLT | 1.000 | -11.2 | -10.87 | 0 | 0 | 0.030 | | | | |
| 7 | TQDMAX | 0.9999 | DCG | 1.000 | 1.8046 | 2.2614 | 4.5474 | 6.4547 | 1.062 | 32.11 | 1 | 1 | 1 |
| | | | PLT | 0.995 | 3.7048 | 3.8293 | 0 | 0 | 0.033 | | | | |
| 3 | QMAX | 0.9999 | DCG | 1.000 | -31.27 | -27.16 | -24 | -22.09 | 0.268 | 42.49 | 2 | 1 | 2 |
| | | | PLT | 0.911 | -26.22 | -26.05 | 0 | 0 | 0.006 | | | | |
| 9 | TQMAX | 0.9999 | DCG | 1.000 | 2.8374 | 3.4827 | 4.5474 | 6.4547 | 0.489 | 15.49 | 1 | 1 | 1 |
| | | | PLT | 0.998 | 4.2622 | 4.3989 | 0 | 0 | 0.032 | | | | |
| 10 | QXSEC | 0.9999 | DCG | 1.000 | -22.77 | -13.95 | -6.712 | -2.238 | 1.549 | 56.31 | 1 | 1 | 1 |
| | (2.0 sec) | | PLT | 0.921 | -11.57 | -11.26 | 0 | 0 | 0.027 | | | | |
| 11 | AOADMX | 0.9999 | DCG | 1.000 | -27.7 | -23.79 | -20.85 | -19.16 | 0.288 | 20.30 | 2 | 1 | 2 |
| | | | PLT | 0.998 | -23.04 | -22.71 | 0 | 0 | 0.014 | | | | |
| 12 | TADMAX | 0.9999 | DCG | 1.000 | 2.8374 | 3.4827 | 4.5474 | 6.4547 | 0.489 | 15.49 | 1 | 1 | 1 |
| | | | PLT | 0.998 | 4.2622 | 4.3989 | 0 | 0 | 0.032 | | | | |
| 13 | ADXSEC | 0.9999 | DCG | 1.000 | -22.18 | -13.92 | -6.574 | -1.889 | 1.538 | 34.54 | 1 | 1 | 1 |
| | (2.0 sec) | | PLT | 0.986 | -11.39 | -10.89 | 0 | 0 | 0.045 | | | | |
| 22 | AOAXSEC | 0.9999 | DCG | 1.000 | 30.269 | 38.193 | 44.682 | 48.726 | 0.399 | 22.14 | 2 | 1 | 2 |
| | (2.0 sec) | | PLT | 0.990 | 40.103 | 40.833 | 0 | 0 | 0.018 | | | | |
| 27 | TCMPLT | 0.9999 | DCG | 1.000 | 2.8374 | 3.4827 | 4.5474 | 6.4547 | 0.489 | 15.49 | 1 | 1 | 1 |
| | | | PLT | 0.998 | 4.2622 | 4.3989 | 0 | 0 | 0.032 | | | | |
| 36 | PS | 0.9999 | DCG | 1.000 | 101.04 | 102.27 | 105.09 | 108.36 | 0.039 | 3.12 | 4 | 1 | 4 |
| | | | PLT | 0.987 | 104.85 | 103.53 | 0 | 0 | -0.013 | | | | |
| 37 | ENERGY | 0.9999 | DCG | 1.000 | -12.6 | -18.22 | -47.01 | -127.7 | -1.732 | 8.34 | 1 | 1 | 1 |
| | | | PLT | 0.997 | -56.65 | -46.09 | 0 | 0 | 0.208 | | | | |
| 38 | VDOTMX | 0.9588 | DCG | 0.898 | 6.58 | 8.2187 | 8.9359 | 7.4474 | 0.311 | 4.19 | 3 | 1 | 3 |
| | | | PLT | 0.613 | 8.0842 | 7.5068 | 0 | 0 | -0.074 | | | | |
| 39 | DELV | 0.9999 | DCG | 1.000 | 9.1754 | 11.442 | 14.02 | 16.513 | 0.437 | 4.83 | 1 | 1 | 1 |
| | | | PLT | 1.000 | 12.21 | 13.365 | 0 | 0 | 0.090 | | | | |
| 40 | GAMDOT | 0.9579 | DCG | 0.819 | -2.6 | -3.114 | -3.065 | -2.48 | -0.165 | 2.73 | 4 | 1 | 4 |
| | | | PLT | 0.517 | -2.9 | -2.729 | 0 | 0 | 0.061 | | | | |
| 41 | TGAMD | 0.9999 | DCG | 1.000 | 2.8292 | 3.4827 | 4.5392 | 6.4547 | 0.491 | 14.63 | 1 | 1 | 1 |
| | | | PLT | 0.998 | 4.254 | 4.3989 | 0 | 0 | 0.034 | | | | |
| 50 | PRR | 0 | DCG | -999.000 | 3 | 4 | 5 | 6 | 0.533 | 0.00 | 4 | 3 | 4 |
| | | | PLT | -999.000 | 4.5 | -999 | 0 | 0 | -112.002 | | | | |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | TPXDEG | 0.9999 | DCG | 1.000 | 2.5833 | 3.1549 | 4.1949 | 6.0612 | 0.960 | 48.33 | 1 | 1 | 1 |
| | (35 deg) | | PLT | 0.984 | 3.9589 | 4.0383 | 0 | 0 | 0.020 | | | | |
| 3 | TCLMAX | 0.9999 | DCG | 1.000 | 1.5423 | 1.9172 | 2.654 | 4.2334 | 1.190 | 33.56 | 1 | 1 | 1 |
| | | | PLT | 0.982 | 2.5408 | 2.6326 | 0 | 0 | 0.035 | | | | |
| 4 | QD0AVG | 0.9999 | DCG | 1.000 | -10.13 | -6.136 | -3.166 | -1.157 | 4.322 | 76.12 | 1 | 1 | 1 |
| | (1.0 sec) | | PLT | 0.987 | -5.293 | -5.001 | 0 | 0 | 0.057 | | | | |
| 5 | QDXSEC | 0.9999 | DCG | 1.000 | -11.65 | -6.692 | -2.894 | -0.882 | 6.565 | 101.51 | 1 | 1 | 1 |
| | (1.0 sec) | | PLT | 0.999 | -5.708 | -5.351 | 0 | 0 | 0.065 | | | | |
| 6 | QDMAX | 0.9999 | DCG | 1.000 | -14.72 | -11.06 | -9.054 | -9.315 | 0.473 | 15.59 | 1 | 1 | 1 |
| | | | PLT | 1.000 | -11.2 | -10.87 | 0 | 0 | 0.030 | | | | |
| 7 | TQDMAX | 0.9999 | DCG | 1.000 | 1.8046 | 2.2614 | 4.5474 | 6.4547 | 1.649 | 49.87 | 1 | 1 | 1 |
| | | | PLT | 0.995 | 3.7048 | 3.8293 | 0 | 0 | 0.033 | | | | |
| 8 | QMAX | 0.9999 | DCG | 1.000 | -31.27 | -27.16 | -24 | -22.09 | 0.354 | 56.28 | 2 | 1 | 2 |
| | | | PLT | 0.911 | -26.22 | -26.05 | 0 | 0 | 0.006 | | | | |
| 9 | TQMAX | 0.9999 | DCG | 1.000 | 2.8374 | 3.4827 | 4.5474 | 6.4547 | 0.918 | 29.04 | 1 | 1 | 1 |
| | | | PLT | 0.998 | 4.2622 | 4.3989 | 0 | 0 | 0.032 | | | | |
| 10 | QXSEC | 0.9999 | DCG | 1.000 | -22.77 | -13.95 | -6.712 | -2.238 | 5.038 | 183.22 | 1 | 1 | 1 |
| | (2.0 sec) | | PLT | 0.921 | -11.57 | -11.26 | 0 | 0 | 0.027 | | | | |
| 11 | AOADMX | 0.9999 | DCG | 1.000 | -27.7 | -23.79 | -20.85 | -19.16 | 0.377 | 26.58 | 2 | 1 | 2 |
| | | | PLT | 0.998 | -23.04 | -22.71 | 0 | 0 | 0.014 | | | | |
| 12 | TADMAX | 0.9999 | DCG | 1.000 | 2.8374 | 3.4827 | 4.5474 | 6.4547 | 0.918 | 29.04 | 1 | 1 | 1 |
| | | | PLT | 0.998 | 4.2622 | 4.3989 | 0 | 0 | 0.032 | | | | |
| 13 | ADXSEC | 0.9999 | DCG | 1.000 | -22.18 | -13.92 | -6.574 | -1.889 | 5.828 | 130.86 | 1 | 1 | 1 |
| | (2.0 sec) | | PLT | 0.986 | -11.39 | -10.89 | 0 | 0 | 0.045 | | | | |
| 22 | AOAXSEC | 0.9999 | DCG | 1.000 | 30.269 | 38.193 | 44.682 | 48.726 | 0.494 | 27.40 | 1 | 1 | 1 |
| | (2.0 sec) | | PLT | 0.990 | 40.103 | 40.833 | 0 | 0 | 0.018 | | | | |
| 27 | TCMPLT | 0.9999 | DCG | 1.000 | 2.8374 | 3.4827 | 4.5474 | 6.4547 | 0.918 | 29.04 | 1 | 1 | 1 |
| | | | PLT | 0.998 | 4.2622 | 4.3989 | 0 | 0 | 0.032 | | | | |
| 36 | PS | 0.9999 | DCG | 1.000 | 101.04 | 102.27 | 105.09 | 108.36 | 0.070 | 5.55 | 4 | 1 | 4 |
| | | | PLT | 0.987 | 104.85 | 103.53 | 0 | 0 | -0.013 | | | | |
| 37 | ENERGY | 0.9999 | DCG | 1.000 | -12.6 | -18.22 | -47.01 | -127.7 | -5.019 | 24.17 | 1 | 1 | 1 |
| | | | PLT | 0.997 | -56.65 | -46.09 | 0 | 0 | 0.208 | | | | |
| 38 | VDOTMX | 0.9588 | DCG | 0.898 | 6.58 | 8.2187 | 8.9359 | 7.4474 | 0.124 | 1.67 | 4 | 2 | 4 |
| | | | PLT | 0.613 | 8.0842 | 7.5068 | 0 | 0 | -0.074 | | | | |
| 39 | DELV | 0.9999 | DCG | 1.000 | 9.1754 | 11.442 | 14.02 | 16.513 | 0.622 | 6.87 | 1 | 1 | 1 |
| | | | PLT | 1.000 | 12.21 | 13.365 | 0 | 0 | 0.090 | | | | |
| 40 | GAMDOT | 0.9579 | DCG | 0.819 | -2.6 | -3.114 | -3.065 | -2.48 | 0.047 | 0.78 | 4 | 3 | 4 |
| | | | PLT | 0.517 | -2.9 | -2.729 | 0 | 0 | 0.061 | | | | |
| 41 | TGAMD | 0.9999 | DCG | 1.000 | 2.8292 | 3.4827 | 4.5392 | 6.4547 | 0.922 | 27.49 | 1 | 1 | 1 |
| | | | PLT | 0.998 | 4.254 | 4.3989 | 0 | 0 | 0.034 | | | | |
| 50 | PRR | 0 | DCG | -999.000 | 3 | 4 | 5 | 6 | 0.750 | 0.01 | 4 | 3 | 4 |
| | | | PLT | -999.000 | 4.5 | -999 | 0 | 0 | -112.002 | | | | |

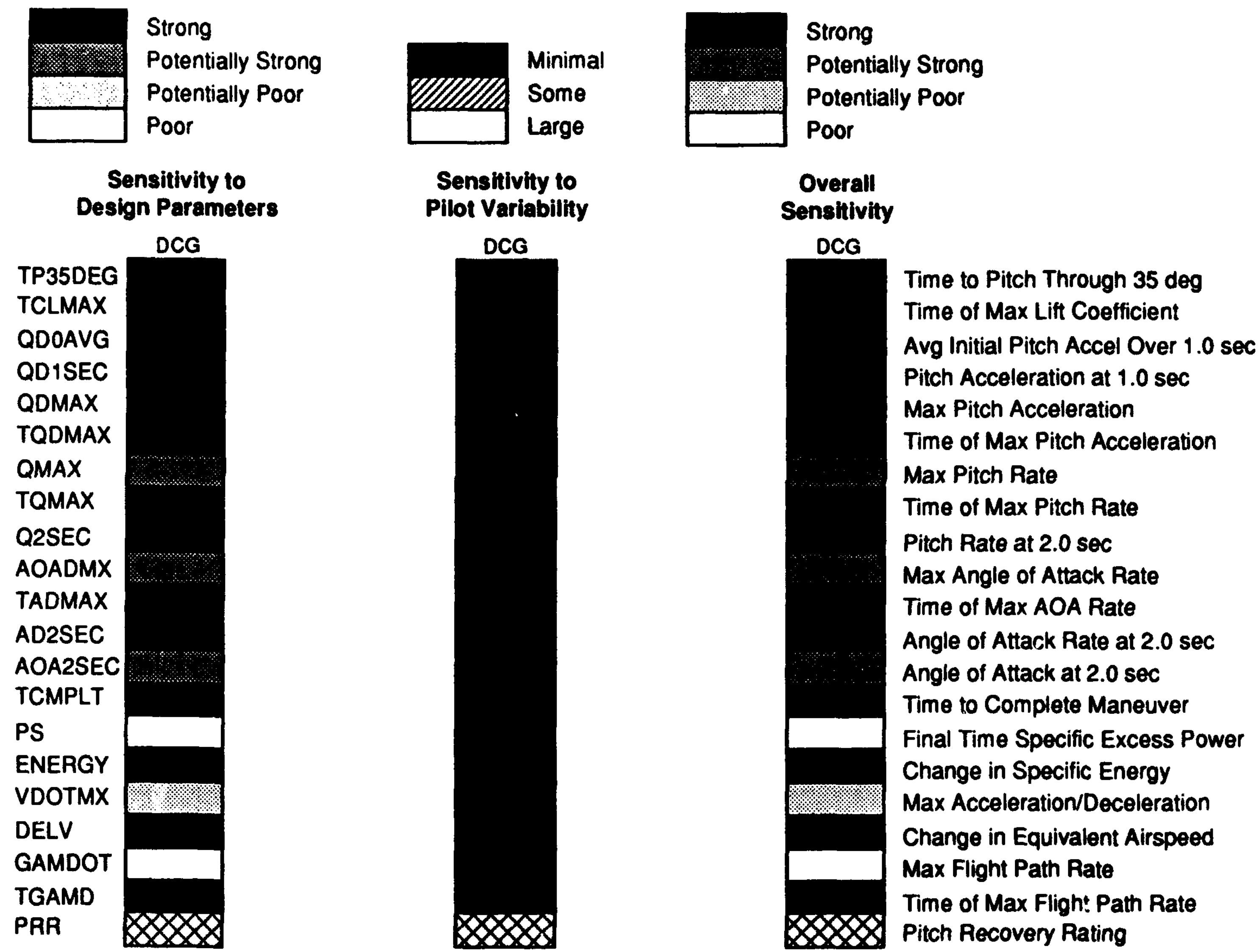
STEM 16 TEST 2



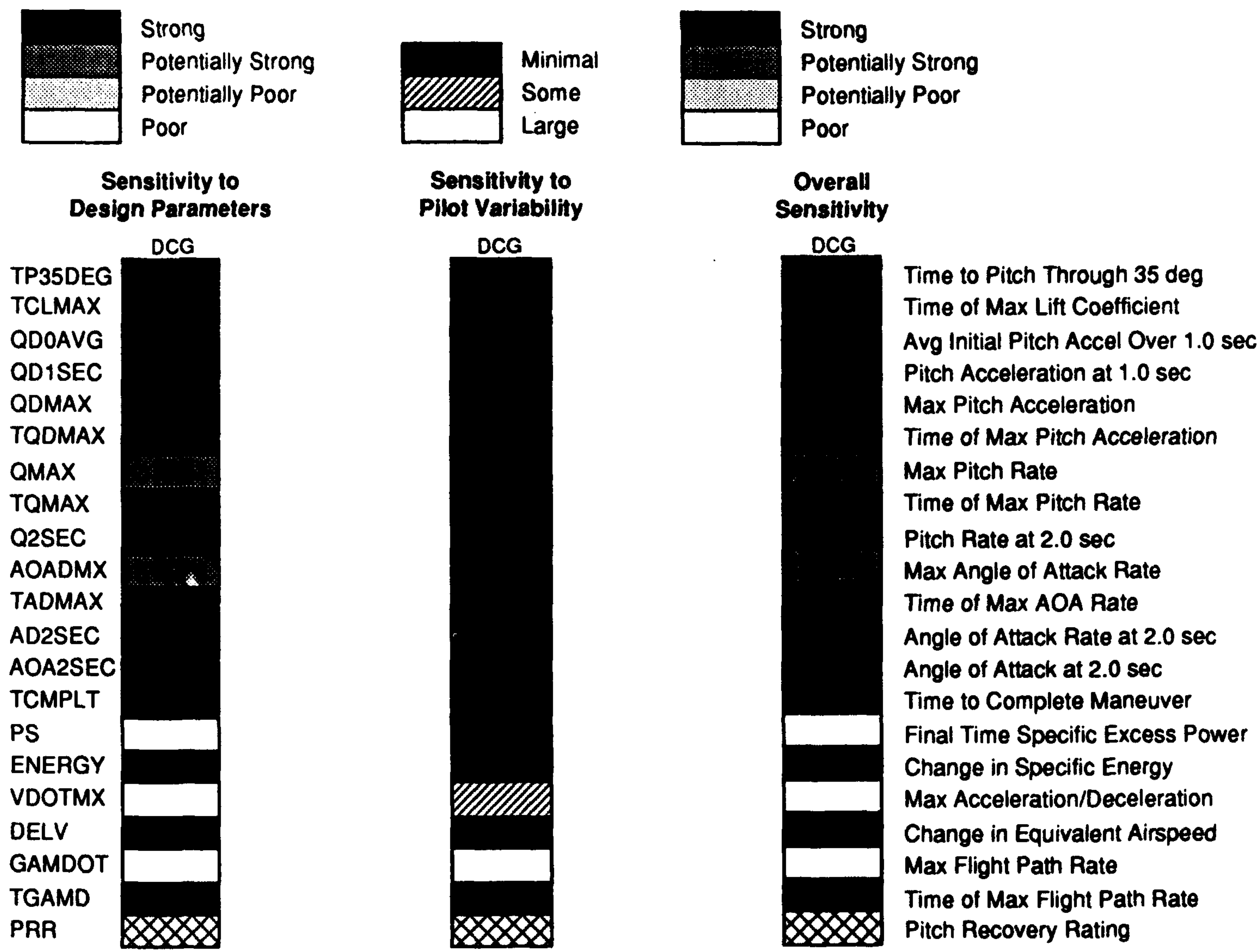
STEM 16 TEST 2 ANALYSIS A



STEM 16 TEST 2 ANALYSIS B



STEM 16 TEST 2 ANALYSIS C



STEM 16 TEST 2
PILOT A
LONGITUDINAL CONFIGURATION 145
LATERAL CONFIGURATION 2
PRR 3

I will be using the Pitch Recovery Rating scale, so I needed to find a mission scenario. The scenario I'm going to use is the standard I've been using during pitch control margin test. I'm in a vertical fight with one other airplane. He's gone uphill before me. He's somewhere up above me, ahead. I go uphill after him and I realize part way up that I'm going to run out of energy, so he's above and behind starting to convert. I'm unloading my nose down to get below 10 AOA so that I can start to gain energy again to come back into the flight. So it's basically, I thought I was offensive. I've switched to defensive and now I'm unloading for energy with a rapidly converging threat above and behind. So that's my mission scenario. And we're going to do the maneuver in a fairly standard manner here and then I'll go through the modified PRR scale. It is a little bit sluggish initially. To set up I am basically leaving power alone and then just playing pitch attitude. Trying to match a design speed which looks to be about 95 knots. Maybe 36 degrees of pitch for 50 alpha. I'm going to go through decision factors first. For that scenario, was there enough pitch response? The rate was good. The acceleration was a little bit slow. I could use more acceleration. The time to recover was okay overall. It could have been a little bit quicker. Recovery was never in question. Pilot compensation - not really. It never occurred to me to do anything else. It was quick enough. I just jammed the stick full forward. Is the response suitable for the mission? It's basically suitable. It could just be a little quicker in initial acceleration response. Going through the decision tree - did the aircraft recover? Yes. Was recovery adequate? Yes. Was recovery highly desirable? No. The pitch control margin was adequate. I would say the recovery was adequate. It was just a little bit slow initially. It degrades the mission slightly. I would like slightly more initial acceleration. It wasn't bad but it could have been improved.

STEM 16 TEST 2
PILOT F
LONGITUDINAL CONFIGURATION 145
LATERAL CONFIGURATION 2

I'll try to stabilize it here at about 50. This configuration I don't really have anything to say about it. It is very stable in pitch. You can stabilize the alpha at about 35 degrees. You push forward, the nose rotates down at what seems like in a very rapid rate. Very stable.

STEM 16 TEST 2
PILOT A
LONGITUDINAL CONFIGURATION 146
LATERAL CONFIGURATION 2
PRR 4

It's coming but it's sluggish. I find myself checking up and then down 3 or 4 times trying to get the nose to come. I get a positive response. I don't think about safety but I sure wish I had a quicker response out of the airplane. The final rate is okay. The overall time is a little slow

but not bad. But that initial acceleration just isn't positive enough. When I jam my stick forward and I go from almost full aft to almost full forward, it's for a reason. And I'm asking for a lot of the airplane and it's not giving me a lot. The time to recover was okay, maybe a little bit slow. Recovery was never in question. Pilot compensation - not really, you just have to be a little bit patient. Response is just barely suitable for the mission. I sure would like it if it was better. Did the aircraft recover? Yes. Was the recovery adequate? It was not very good. I would prefer if the acceleration was better. It was just a little bit too slow for me. This is the dividing line between adequate and inadequate where I think that was just slightly over the line towards inadequate. I need a little more nose response than that. So I'm going to say it was not really suitable for the mission. It was inadequate. I really need more pitch control margin. More initial acceleration.

STEM 16 TEST 2
PILOT F
LONGITUDINAL CONFIGURATION 146
LATERAL CONFIGURATION 2

This one seems a little lighter in pitch. This one seems just a tad slower (than longitudinal configuration 145). This configuration seems a little slower as far as responding to initial full forward stick. Not a lot, but enough to notice. Also, I had a little trouble hitting 50 there. I was wandering around 50, and I had to drop my pitch a little more than normal to get started so I don't know what that's telling me about the pitch control system but I did have to take an extra second or two to get 50 angle of attack nailed. Again, on the other configuration when I put the stick forward I had a real nice solid feel that the nose was coming down. It was like the nose and the stick rate were right there together. On this one I push, there's just a slight hesitation and the nose starts falling off. It just doesn't feel as tight as the other one.

STEM 16 TEST 2
PILOT A
LONGITUDINAL CONFIGURATION 147
LATERAL CONFIGURATION 2
PRR 5

That's sluggish, lousy. You could almost make a direct correlation between the response and the number of times you curse it. That was worth two curses and a complaint. There's actually a moment there where you're thinking, shoot, is the nose going to come or not. This airplane is right in the threshold of just barely hacking it. There is a definite moment there where you would take your attention away from the task and look inside to see what is going on with the airplane as to how come the nose hasn't come down yet. Was there enough pitch response? No. The acceleration was much too slow. Final rate eventually got fast enough but the onset acceleration was way too slow. I could definitely use more response. The time to recover was too long. Recovery was actually momentarily in question. You ran the stick full forward and you get such a sluggish response that.you no longer think about the mission, you start thinking about safety. Pilot compensation was definitely required. I had to take my attention away from the mission and think about the airplane for a minute. Was the response suitable for the mission? No. Did the aircraft recover? Yes. Recover adequate? No. Recovery was momentarily

in doubt. That was archtypical pilot rating 5. If it got a hair worse than that I would now be abandoning the mission task and start thinking just about safety and that would take me over the threshold out of level B recovery. So what I need is a more positive onset of initial acceleration. So for the AX kind of testing this type of response there is what defines the boundary of goodness. That's about as bad as you want to see.

STEM 16 TEST 2
PILOT F
LONGITUDINAL CONFIGURATION 147
LATERAL CONFIGURATION 2

Significantly slow onset rate. The forward stick causes a slower nose response than the other two (longitudinal configuration 145 and 146). It's a slower response to full forward stick input. Especially at the initiation of the maneuver. It just hangs up there just a little bit when I hit the full forward stop. The nose just floats or hangs there just for a second. A little bit longer than the other two configurations. After the momentum starts building I can't tell the difference between the three. Once you break through about 5 degrees pitch attitude on the way down hill it seems all about the same rate to me.

STEM 16 TEST 2
PILOT A
LONGITUDINAL CONFIGURATION 148
LATERAL CONFIGURATION 2
PRR 6

Oh come on. Task abandonment. My focus would definitely come inside the cockpit. Just looking at the pitch rate, it looks to me like I'd be very concerned there. I'm not sure what the seat of the pants feel would be like but it sure looks very inadequate. Just not what a pilot wants to see when he puts the stick to the stop. I think anybody under those circumstances would stop worrying about whether he's going to get shot and start worrying about whether he's going to recover or not. We've stepped over the line. The initial response is so slow there I'd be worried that I'm in an alpha hang up. Time to start thinking of some alternate means of recovering the airplane and forget about what else is going on. And the technique we're using here: Pulling the nose up, letting the airspeed get down to the target of about 96 to 97, then slowly letting the nose fall as my alpha builds so that I'm about 34 degrees pitch, 97 knots, almost stable at 50 alpha when I do my pushover. Was there enough pitch response? Negative. Much too slow acceleration. The rate was way too slow in coming. I need more. The time to recover was too long. The recovery was in question. Pilot compensation - was definitely there. I would have had to give up what I was doing and look down and figure if I was going to hit the ground regardless of whether he shot me or not. And the response is unsuitable for the mission. But the aircraft did recover. It was inadequate. Recovery was in doubt for an excessive period. Mission task was secondary. Safety became the primary objective. We just stepped over that line. We just got to the point where I don't care what the bogey does I need to start paying attention right now to see if I need to do something else. If I was in a F-16 it would be time to start thinking about whether I'm in a pitch rock situation. In a Hornet, I'd be thinking about going to my bold face procedures to analyze if I'm in an AOA hang up. So the

mission task did become secondary and recovery was in doubt for an excessive period.

STEM 16 TEST 2
PILOT F
LONGITUDINAL CONFIGURATION 148
LATERAL CONFIGURATION 2

That one I could tell the difference in the rate all the way to level pitch attitude. That one was significantly slower than the other ones. We get a real slow fall off on that. This one has very little if any initial response to stick input for almost a second. Then there's a slow pitch acceleration that doesn't really do a whole lot other than it started moving slow till about 30 degrees pitch then it picks up a little bit more and then at about level pitch attitude the starts picking up. But at that point it is probably due to gravity. There is almost a second and a half of full forward stick before you get any significant rate.

## Data Contents for STEM 17: J-Turn

AOA Command systems

- Summary of Design Parameter Variations Tested

The following information is repeated for Analyses A and B

- Numerical Summary of Statistical Analysis
- Bar Graphs of Measures of Merit
- Design Parameter Correlations, Pilot Variability, and Overall Correlations

The following information is located after Analyses A, and B

- Pilot Comments

Two statistical analyses are included to test different sets of design parameters. If only one analysis is of interest, then Analysis A should be used. The following is a list of the analyses included for STEM 17:

A Test matrix consists of CAP and PMAX
B Test matrix consists of CMDTYP and PMAX

## Design Parameters Tested for STEM 17

Test variables:

CAP: Indicates a variation in CAP:

(-) 0.3, Level 1/2 boundary from MIL-STD-1797A

(+) 0.60, Within the Level 1 region from MIL-STD-1797A and generally good for acquisition

PMAX: Variations in maximum roll rate were implemented. The variations were expected to cover a range of poor and good dynamics:

(-) low, a schedule of PMAX with AOA was implemented based on MIL-STD-1797A and MCAIR high AOA research.

| AOA | PMAX |
|---|---|
| 5° | 150.0 deg/sec |
| 15° | 100.0 deg/sec |
| 30° | 50.0 deg/sec |
| 60° | 30.0 deg/sec |

(+) high, a schedule of PMAX with AOA was implemented based on MIL-STD-1797A and MCAIR high AOA research.

| AOA | PMAX |
|---|---|
| 5° | 180.0 deg/sec |
| 15° | 150.0 deg/sec |
| 30° | 90.0 deg/sec |
| 60° | 60.0 deg/sec |

CMDTYP: Indicates longitudinal command type:

(-) AOA

(+) q

## Test Matrix for Analysis A (Pilots F, H)

| Lon Config | Lat Config | CAP | PMAX |
|---|---|---|---|
| 304 | 202 | 0.6 (+) | high (-) |
| 305 | 202 | 0.3 (-) | high (-) |
| 304 | 203 | 0.6 (+) | low (+) |
| 305 | 203 | 0.3 (-) | low (+) |

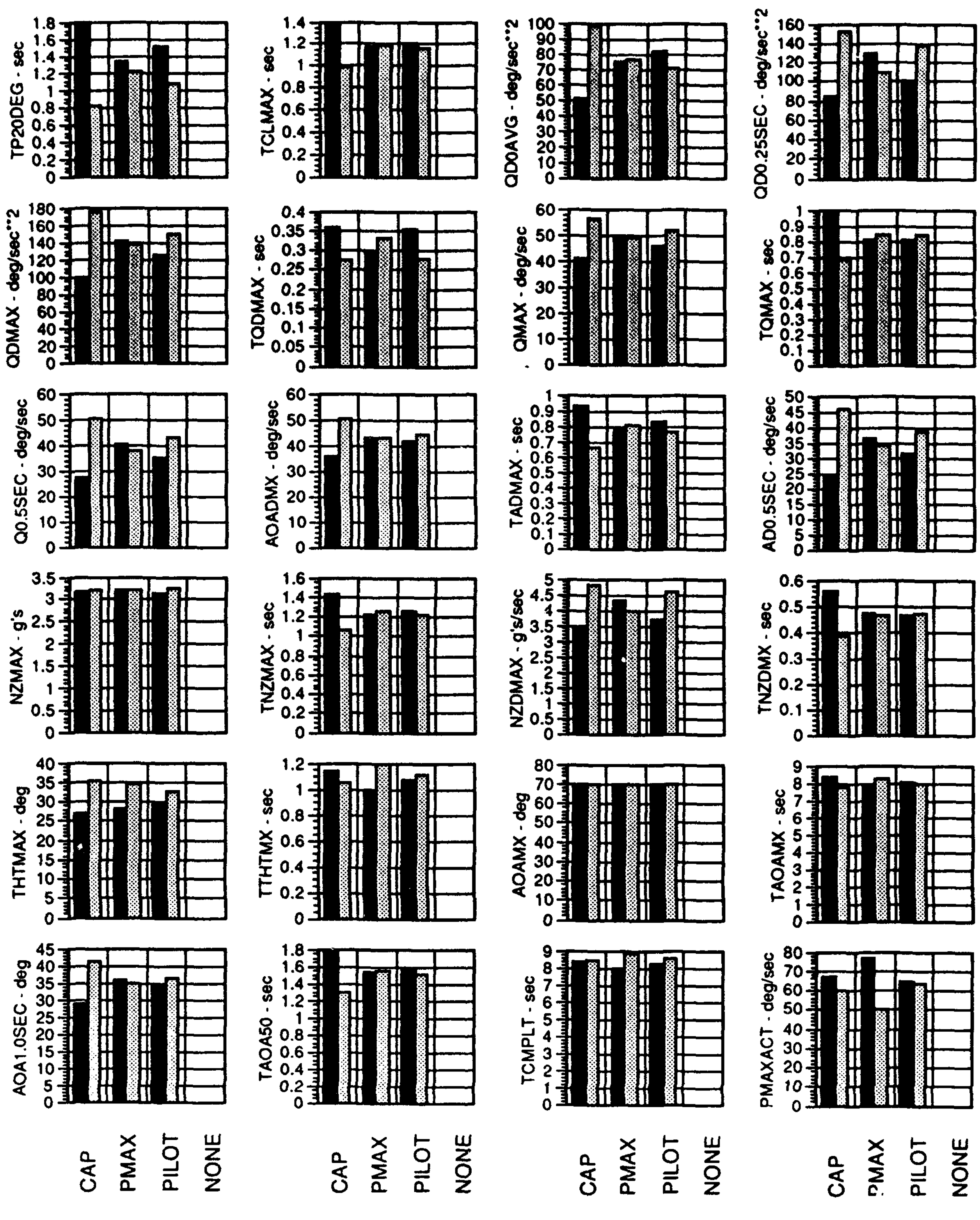
## Test Matrix for Analysis B (Pilots F, H)

| Lon Config | Lat Config | CMDTYP | PMAX |
|---|---|---|---|
| 304 | 202 | AOA (-) | high (-) |
| 304 | 203 | AOA (-) | low (+) |
| 712 | 202 | q (+) | high (-) |
| 712 | 203 | q (+) | low (+) |

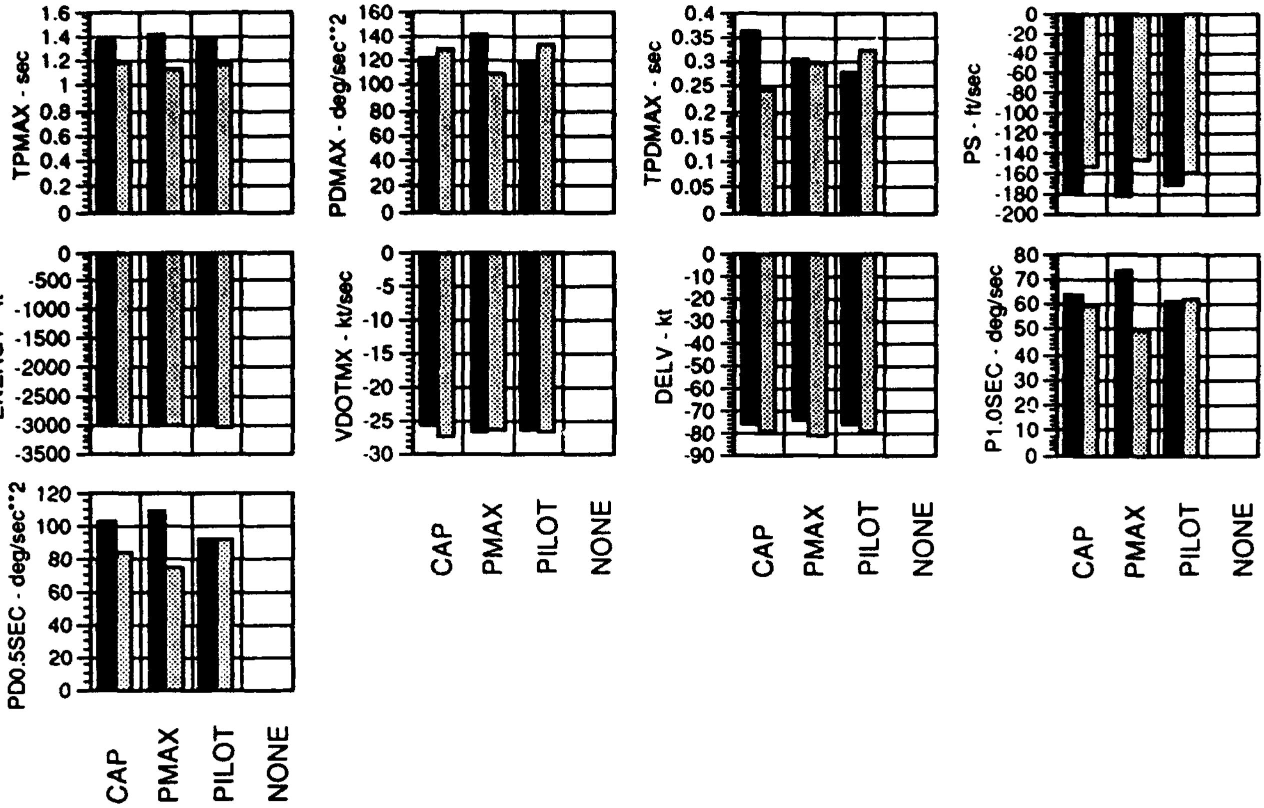
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | TPXDEG | 0.9999 | CAP | 1.000 | 1.794 | 0.8088 | 0 | 0 | -0.884 | 2.43 | 1 | 1 | 1 |
| | (20 deg) | | PMAX | 0.758 | 1.3421 | 1.2163 | 0 | 0 | -0.099 | 0.27 | 4 | 3 | 4 |
| | | | PLT | 0.994 | 1.5184 | 1.0632 | 0 | 0 | -0.364 | | | | |
| 3 | TCLMAX | 0.9999 | CAP | 1.000 | 1.3815 | 0.9973 | 0 | 0 | -0.332 | 7.19 | 2 | 1 | 2 |
| | | | PMAX | 0.066 | 1.1729 | 1.1913 | 0 | 0 | 0.016 | 0.34 | 4 | 3 | 4 |
| | | | PLT | 0.623 | 1.2101 | 1.1556 | 0 | 0 | -0.046 | | | | |
| 4 | QD0AVG | 0.9872 | CAP | 1.000 | 50.879 | 98.759 | 0 | 0 | 0.713 | 4.75 | 1 | 1 | 1 |
| | (0.25 deg) | | PMAX | 0.208 | 75.289 | 76.305 | 0 | 0 | 0.013 | 0.09 | 4 | 3 | 4 |
| | | | PLT | 0.764 | 81.67 | 70.337 | 0 | 0 | -0.150 | | | | |
| 5 | QDXSEC | 0.9999 | CAP | 1.000 | 84.77 | 152.44 | 0 | 0 | 0.621 | 1.95 | 1 | 2 | 2 |
| | (0.25 deg) | | PMAX | 0.917 | 129.8 | 109.3 | 0 | 0 | -0.173 | 0.54 | 3 | 3 | 4 |
| | | | PLT | 0.997 | 100.71 | 137.73 | 0 | 0 | 0.318 | | | | |
| 6 | QDMAX | 0.9999 | CAP | 1.000 | 99.002 | 175.15 | 0 | 0 | 0.602 | 3.41 | 1 | 1 | 1 |
| | | | PMAX | 0.103 | 140.3 | 136.75 | 0 | 0 | -0.026 | 0.14 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 126.01 | 150.22 | 0 | 0 | 0.177 | | | | |
| 7 | TQDMAX | 0.6663 | CAP | 0.934 | 0.3565 | 0.2742 | 0 | 0 | -0.266 | 1.13 | 2 | 2 | 3 |
| | | | PMAX | 0.568 | 0.2959 | 0.333 | 0 | 0 | 0.118 | 0.50 | 4 | 3 | 4 |
| | | | PLT | 0.880 | 0.3517 | 0.2786 | 0 | 0 | -0.235 | | | | |
| 8 | QMAX | 0.9999 | CAP | 1.000 | 40.912 | 56.428 | 0 | 0 | 0.327 | 2.60 | 2 | 1 | 2 |
| | | | PMAX | 0.305 | 49.179 | 48.765 | 0 | 0 | -0.008 | 0.07 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 45.802 | 51.914 | 0 | 0 | 0.126 | | | | |
| 9 | TQMAX | 0.9993 | CAP | 1.000 | 0.969 | [illegible] | 0 | 0 | -0.347 | 10.87 | 2 | 1 | 2 |
| | | | PMAX | 0.257 | 0.8113 | 0.8371 | 0 | 0 | 0.031 | 0.98 | 4 | 3 | 4 |
| | | | PLT | 0.583 | 0.8101 | 0.8363 | 0 | 0 | 0.032 | | | | |
| 10 | QXSEC | 0.9999 | CAP | 1.000 | 26.922 | 50.665 | 0 | 0 | 0.675 | 3.35 | 1 | 1 | 1 |
| | (0.5 sec) | | PMAX | 0.348 | 40.393 | 38.05 | 0 | 0 | -0.060 | 0.30 | 4 | 3 | 4 |
| | | | PLT | 0.958 | 35.211 | 43.013 | 0 | 0 | 0.201 | | | | |
| 11 | AOADMX | 0.9999 | CAP | 1.000 | 35.473 | 50.116 | 0 | 0 | 0.352 | 4.90 | 2 | 1 | 2 |
| | | | PMAX | 0.086 | 43.375 | 42.775 | 0 | 0 | -0.014 | 0.19 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 41.48 | 44.571 | 0 | 0 | 0.072 | | | | |
| 12 | TADMAX | 0.9991 | CAP | 1.000 | 0.9315 | 0.6665 | 0 | 0 | -0.341 | 4.26 | 2 | 1 | 2 |
| | | | PMAX | 0.431 | 0.7767 | 0.8121 | 0 | 0 | 0.045 | 0.56 | 4 | 3 | 4 |
| | | | PLT | 0.756 | 0.8267 | 0.7632 | 0 | 0 | -0.080 | | | | |
| 13 | ADXSEC | 0.9999 | CAP | 1.000 | 23.979 | 45.875 | 0 | 0 | 0.695 | 3.37 | 1 | 1 | 1 |
| | (0.5 sec) | | PMAX | 0.402 | 36.492 | 34.144 | 0 | 0 | -0.067 | 0.32 | 4 | 3 | 4 |
| | | | PLT | 0.962 | 31.63 | 38.813 | 0 | 0 | 0.206 | | | | |
| 14 | NZMAX | 0.9981 | CAP | 0.910 | 3.1825 | 3.2217 | 0 | 0 | 0.012 | 0.37 | 4 | 3 | 4 |
| | | | PMAX | 0.011 | 3.2038 | 3.202 | 0 | 0 | -0.001 | 0.02 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 3.1472 | 3.2543 | 0 | 0 | 0.033 | | | | |
| 15 | TNZMAX | 0.9999 | CAP | 1.000 | 1.4399 | 1.0511 | 0 | 0 | -0.320 | 7.77 | 2 | 1 | 2 |
| | | | PMAX | 0.288 | 1.2229 | 1.2538 | 0 | 0 | 0.025 | 0.61 | 4 | 3 | 4 |
| | | | PLT | 0.585 | 1.2642 | 1.2132 | 0 | 0 | -0.041 | | | | |
| 16 | NZDMAX | 0.9999 | CAP | 1.000 | 3.4969 | 4.7856 | 0 | 0 | 0.319 | 1.45 | 2 | 2 | 3 |
| | | | PMAX | 0.973 | 4.3244 | 3.9965 | 0 | 0 | -0.079 | 0.36 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 3.6975 | 4.6004 | 0 | 0 | 0.220 | | | | |
| 17 | TNZDMX | 0.9595 | CAP | 0.999 | 0.5565 | 0.3857 | 0 | 0 | -0.375 | 26.15 | 2 | 1 | 2 |
| | | | PMAX | 0.167 | 0.469 | 0.4663 | 0 | 0 | -0.006 | 0.41 | 4 | 3 | 4 |
| | | | PLT | 0.231 | 0.4642 | 0.4709 | 0 | 0 | 0.014 | | | | |
| 18 | THTMAX | 0.9999 | CAP | 1.000 | 26.818 | 35.239 | 0 | 0 | 0.276 | 2.88 | 2 | 1 | 2 |
| | | | PMAX | 1.000 | 28.265 | 34.374 | 0 | 0 | 0.197 | 2.05 | 3 | 1 | 3 |
| | | | PLT | 1.000 | 29.646 | 32.629 | 0 | 0 | 0.096 | | | | |
| 19 | TTHTMX | 0.9903 | CAP | 0.947 | 1.1399 | 1.0434 | 0 | 0 | -0.089 | 2.35 | 4 | 1 | 4 |
| | | | PMAX | 1.000 | 0.9921 | 1.1955 | 0 | 0 | 0.188 | 4.98 | 3 | 1 | 3 |
| | | | PLT | 0.722 | 1.0684 | 1.1094 | 0 | 0 | 0.038 | | | | |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | AOAMX | 0.9999 | CAP | 1.000 | 69.867 | 70.057 | 0 | 0 | 0.003 | 3.17 | 4 | 1 | 4 |
| | | | PMAX | 1.000 | 69.895 | 70.043 | 0 | 0 | 0.002 | 2.47 | 4 | 1 | 4 |
| | | | PLT | 0.980 | 69.935 | 69.995 | 0 | 0 | 0.001 | | | | |
| 21 | TAOAMX | 0.9999 | CAP | 1.000 | 8.3607 | 7.755 | 0 | 0 | -0.075 | 5.23 | 4 | 1 | 4 |
| | | | PMAX | 0.997 | 7.8536 | 8.2538 | 0 | 0 | 0.050 | 3.46 | 4 | 1 | 4 |
| | | | PLT | 0.508 | 8.1059 | 7.9902 | 0 | 0 | -0.014 | | | | |
| 22 | AOAXSEC | 0.9999 | CAP | 1.000 | 28.655 | 41.35 | 0 | 0 | 0.375 | 6.27 | 2 | 1 | 2 |
| | (1.0 sec) | | PMAX | 0.095 | 35.577 | 34.908 | 0 | 0 | -0.019 | 0.32 | 4 | 3 | 4 |
| | | | PLT | 0.706 | 34.163 | 36.266 | 0 | 0 | 0.060 | | | | |
| 24 | TAOA50 | 0.9999 | CAP | 1.000 | 1.7899 | 1.3011 | 0 | 0 | -0.324 | 7.93 | 2 | 1 | 2 |
| | | | PMAX | 0.145 | 1.5229 | 1.5496 | 0 | 0 | 0.017 | 0.43 | 4 | 3 | 4 |
| | | | PLT | 0.678 | 1.5684 | 1.5056 | 0 | 0 | -0.041 | | | | |
| 27 | TCMPLT | 0.9999 | CAP | 0.883 | 8.3607 | 8.4704 | 0 | 0 | 0.013 | 0.53 | 4 | 3 | 4 |
| | | | PMAX | 1.000 | 7.996 | 8.8746 | 0 | 0 | 0.104 | 4.24 | 3 | 1 | 3 |
| | | | PLT | 0.998 | 8.3101 | 8.5171 | 0 | 0 | 0.025 | | | | |
| 30 | PMAXACT | 0.9999 | CAP | 1.000 | 67.431 | 60.449 | 0 | 0 | -0.110 | 7.94 | 3 | 1 | 3 |
| | | | PMAX | 1.000 | 76.598 | 49.936 | 0 | 0 | -0.441 | 31.96 | 1 | 1 | 1 |
| | | | PLT | 0.963 | 64.258 | 63.377 | 0 | 0 | -0.014 | | | | |
| 31 | TPMAX | 0.9999 | CAP | 0.997 | 1.369 | 1.1819 | 0 | 0 | -0.148 | 0.89 | 3 | 3 | 4 |
| | | | PMAX | 1.000 | 1.4075 | 1.1246 | 0 | 0 | -0.226 | 1.37 | 2 | 2 | 3 |
| | | | PLT | 0.999 | 1.3809 | 1.1709 | 0 | 0 | -0.166 | | | | |
| 32 | PDMAX | 0.9999 | CAP | 0.938 | 122.85 | 128.53 | 0 | 0 | 0.045 | 0.40 | 4 | 3 | 4 |
| | | | PMAX | 1.000 | 140.79 | 109.56 | 0 | 0 | -0.253 | 2.22 | 2 | 1 | 2 |
| | | | PLT | 1.000 | 118.36 | 132.67 | 0 | 0 | 0.114 | | | | |
| 33 | TPDMAX | 0.5743 | CAP | 0.957 | 0.3607 | 0.2434 | 0 | 0 | -0.403 | 2.71 | 1 | 1 | 1 |
| | | | PMAX | 0.184 | 0.3036 | 0.2955 | 0 | 0 | -0.027 | 0.18 | 4 | 3 | 4 |
| | | | PLT | 0.619 | 0.2767 | 0.3209 | 0 | 0 | 0.149 | | | | |
| 36 | PS | 0.9999 | CAP | 1.000 | -178.1 | -154.1 | 0 | 0 | 0.145 | 2.16 | 3 | 1 | 3 |
| | | | PMAX | 1.000 | -183.3 | -146.4 | 0 | 0 | 0.226 | 3.37 | 2 | 1 | 2 |
| | | | PLT | 1.000 | -171.4 | -160.3 | 0 | 0 | 0.067 | | | | |
| 37 | ENERGY | 0.8089 | CAP | 0.129 | -3016 | -3012 | 0 | 0 | 0.001 | 0.06 | 4 | 3 | 4 |
| | | | PMAX | 0.358 | -3009 | -3019 | 0 | 0 | -0.004 | 0.17 | 4 | 3 | 4 |
| | | | PLT | 0.989 | -2981 | -3044 | 0 | 0 | -0.021 | | | | |
| 38 | VDOTMX | 0.5972 | CAP | 0.903 | -25.93 | -27.33 | 0 | 0 | -0.053 | 11.72 | 4 | 1 | 4 |
| | | | PMAX | 0.023 | -26.69 | -26.62 | 0 | 0 | 0.003 | 0.65 | 4 | 3 | 4 |
| | | | PLT | 0.064 | -26.59 | -26.71 | 0 | 0 | -0.004 | | | | |
| 39 | DELV | 0.9999 | CAP | 1.000 | -76.02 | -79.24 | 0 | 0 | -0.041 | 1.01 | 4 | 2 | 4 |
| | | | PMAX | 1.000 | -74.57 | -81.08 | 0 | 0 | -0.084 | 2.04 | 4 | 1 | 4 |
| | | | PLT | 1.000 | -76.04 | -79.22 | 0 | 0 | -0.041 | | | | |
| 46 | PXSEC | 0.9999 | CAP | 0.985 | 63.901 | 59.447 | 0 | 0 | -0.072 | 3.84 | 4 | 1 | 4 |
| | (1.0 sec) | | PMAX | 1.000 | 73.105 | 49.105 | 0 | 0 | -0.409 | 21.68 | 1 | 1 | 1 |
| | | | PLT | 0.206 | 60.982 | 62.142 | 0 | 0 | 0.019 | | | | |
| 47 | PDXSEC | 0.9998 | CAP | 0.996 | 101.86 | 83.13 | 0 | 0 | -0.205 | 188464 | 2 | 1 | 2 |
| | (0.5 sec) | | PMAX | 1.000 | 108.29 | 74.605 | 0 | 0 | -0.381 | 351208 | 2 | 1 | 2 |
| | | | PLT | 0.077 | 92.12 | 92.12 | 0 | 0 | 0.000 | | | | |

STEM 17 ANALYSIS A



STEM 17 ANALYSIS A



STEM 17 ANALYSIS A

Sensitivity to Design Parameters: Strong / Potentially Strong / Potentially Poor / Poor

Sensitivity to Pilot Variability: Minimal / Some / Large

| | Sensitivity to Design Parameters CAP | Sensitivity to Design Parameters PMAX | Sensitivity to Pilot Variability CAP | Sensitivity to Pilot Variability PMAX | |
|---|---|---|---|---|---|
| TP20DEG | Strong | Poor | Minimal | Large | Time to Pitch Through 20° |
| TCLMAX | Potentially Strong | Poor | Minimal | Large | Time of Max Lift Coefficient |
| QD0AVG | Strong | Poor | Minimal | Large | Avg Initial Pitch Accel Over 0.25 sec |
| QD0.25SEC | Strong | Potentially Poor | Some | Large | Pitch Acceleration at 0.25 sec |
| QDMAX | Strong | Poor | Minimal | Large | Max Pitch Acceleration |
| TQDMAX | Potentially Strong | Poor | Some | Large | Time of Max Pitch Acceleration |
| QMAX | Potentially Strong | Poor | Minimal | Large | Max Pitch Rate |
| TQMAX | Potentially Strong | Poor | Minimal | Large | Time of Max Pitch Rate |
| Q0.5SEC | Strong | Poor | Minimal | Large | Pitch Rate at 0.5 sec |
| AOADMX | Potentially Strong | Poor | Minimal | Large | Max Angle of Attack Rate |
| TADMAX | Potentially Strong | Poor | Minimal | Large | Time of Max AOA Rate |
| AD0.5SEC | Strong | Poor | Minimal | Large | Angle of Attack Rate at 0.5 sec |
| NZMAX | Poor | Poor | Large | Large | Max Load Factor |
| TNZMAX | Potentially Strong | Poor | Minimal | Large | Time of Max Load Factor |
| NZDMAX | Potentially Strong | Poor | Some | Large | Max Load Factor Rate |
| TNZDMX | Potentially Strong | Poor | Minimal | Large | Time of Max Load Factor Rate |
| THTMAX | Potentially Strong | Potentially Poor | Minimal | Minimal | Max Incremental Pitch Attitude |
| TTHTMX | Poor | Potentially Poor | Minimal | Minimal | Time of Max Pitch Attitude |
| AOAMAX | Poor | Poor | Minimal | Minimal | Maximum Angle of Attack |
| TAOAMX | Poor | Poor | Minimal | Minimal | Time of Max Angle of Attack |
| AOA1.0SEC | Potentially Strong | Poor | Minimal | Large | Angle of Attack at 1.0 sec |
| TAOA50 | Potentially Strong | Poor | Minimal | Large | Time to 50° Angle of Attack |
| TCMPLT | Poor | Potentially Poor | Large | Minimal | Time to Complete Maneuver |
| PMAXACT | Potentially Poor | Strong | Minimal | Minimal | Max Stability Axis Roll Rate |
| TPMAX | Potentially Poor | Potentially Strong | Large | Some | Time of Max Roll Rate |
| PDMAX | Poor | Potentially Strong | Large | Minimal | Max Stability Axis Roll Accel |
| TPDMAX | Strong | Poor | Minimal | Large | Time of Max Roll Acceleration |
| PS | Potentially Poor | Potentially Strong | Minimal | Minimal | Final Time Specific Excess Power |
| ENERGY | Poor | Poor | Large | Large | Change in Specific Energy |
| VDOTMX | Poor | Poor | Minimal | Large | Max Acceleration/Deceleration |
| DELV | Poor | Poor | Some | Minimal | Change in Equivalent Airspeed |
| P1.0SEC | Poor | Strong | Minimal | Minimal | Stability Axis Roll Rate at 1.0 sec |
| PD0.5SEC | Potentially Strong | Potentially Strong | Minimal | Minimal | Stability Axis Roll Acceleration at 0.5 sec |

## STEM 17 ANALYSIS A

| | |
|---|---|
| ■ (black) | Strong |
| ▩ (dark shading) | Potentially Strong |
| ░ (light shading) | Potentially Poor |
| □ (white) | Poor |

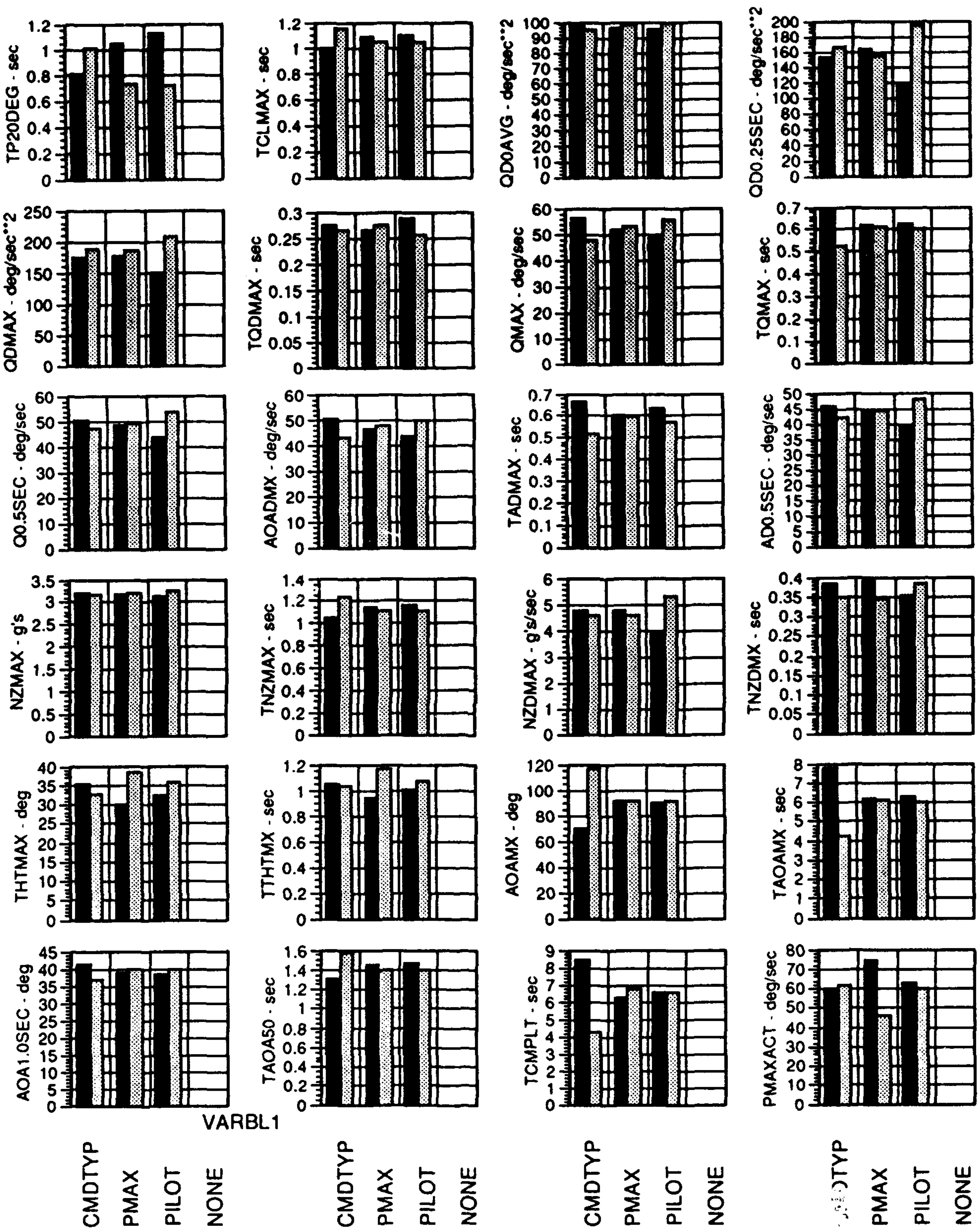
**Overall Sensitivity**

| | CAP | PMAX | |
|---|---|---|---|
| TP20DEG | Strong | Poor | Time to Pitch Through 20° |
| TCLMAX | Potentially Strong | Poor | Time of Max Lift Coefficient |
| QD0AVG | Strong | Poor | Avg Initial Pitch Accel Over 0.25 sec |
| QD0.25SEC | Potentially Strong | Poor | Pitch Acceleration at 0.25 sec |
| QDMAX | Strong | Poor | Max Pitch Acceleration |
| TQDMAX | Potentially Poor | Poor | Time of Max Pitch Acceleration |
| QMAX | Potentially Strong | Poor | Max Pitch Rate |
| TQMAX | Potentially Strong | Poor | Time of Max Pitch Rate |
| Q0.5SEC | Strong | Poor | Pitch Rate at 0.5 sec |
| AOADMX | Potentially Strong | Poor | Max Angle of Attack Rate |
| TADMAX | Potentially Strong | Poor | Time of Max AOA Rate |
| AD0.5SEC | Strong | Poor | Angle of Attack Rate at 0.5 sec |
| NZMAX | Poor | Poor | Max Load Factor |
| TNZMAX | Potentially Strong | Poor | Time of Max Load Factor |
| NZDMAX | Potentially Poor | Poor | Max Load Factor Rate |
| TNZDMX | Potentially Strong | Poor | Time of Max Load Factor Rate |
| THTMAX | Potentially Strong | Potentially Poor | Max Incremental Pitch Attitude |
| TTHTMX | Poor | Potentially Poor | Time of Max Pitch Attitude |
| AOAMAX | Poor | Poor | Maximum Angle of Attack |
| TAOAMX | Poor | Poor | Time of Max Angle of Attack |
| AOA1.0SEC | Potentially Strong | Poor | Angle of Attack at 1.0 sec |
| TAOA50 | Potentially Strong | Poor | Time to 50° Angle of Attack |
| TCMPLT | Poor | Potentially Poor | Time to Complete Maneuver |
| PMAXACT | Potentially Poor | Strong | Max Stability Axis Roll Rate |
| TPMAX | Poor | Potentially Poor | Time of Max Roll Rate |
| PDMAX | Poor | Potentially Strong | Max Stability Axis Roll Accel |
| TPDMAX | Strong | Poor | Time of Max Roll Acceleration |
| PS | Potentially Poor | Potentially Strong | Final Time Specific Excess Power |
| ENERGY | Poor | Poor | Change in Specific Energy |
| VDOTMX | Poor | Poor | Max Acceleration/Deceleration |
| DELV | Poor | Poor | Change in Equivalent Airspeed |
| P1.0SEC | Poor | Strong | Stability Axis Roll Rate at 1.0 sec |
| PD0.5SEC | Potentially Strong | Potentially Strong | Stability Axis Roll Acceleration at 0.5 sec |

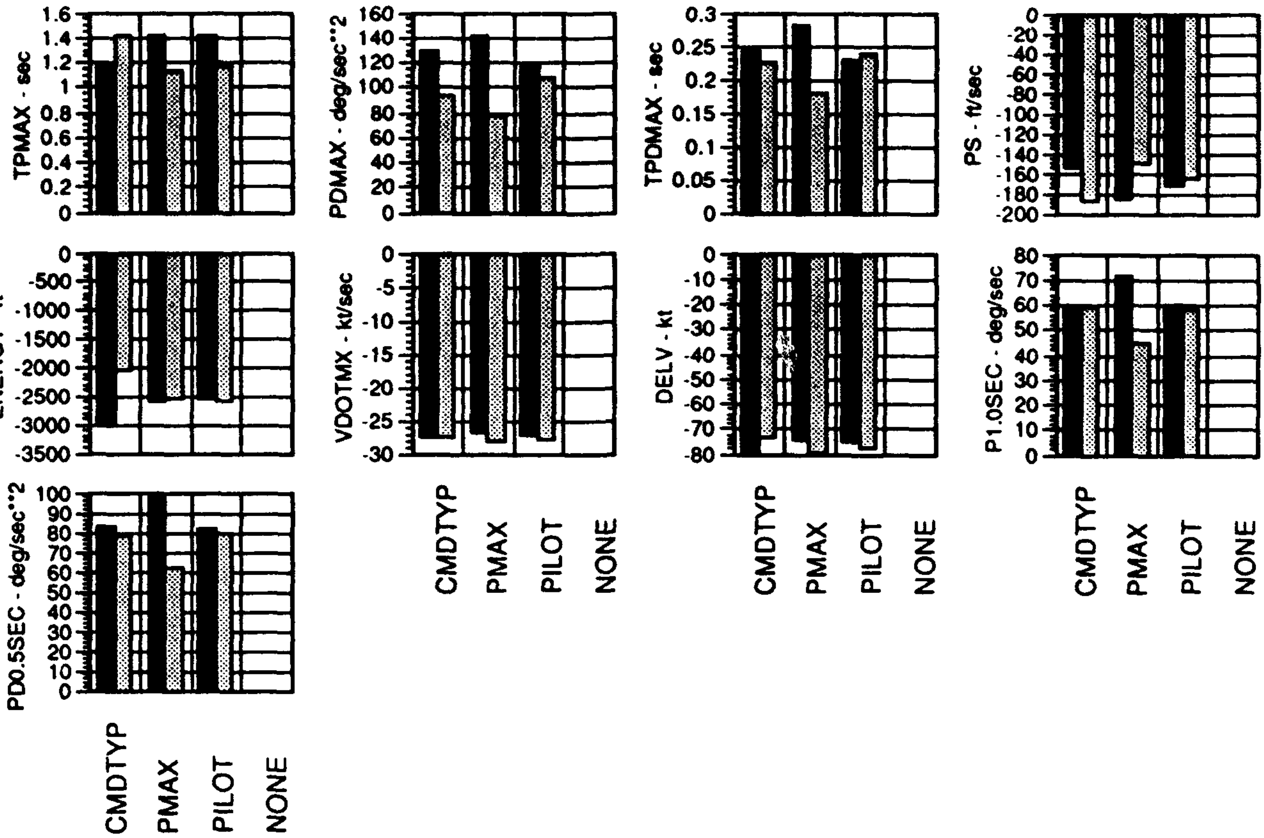
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | TPXDEG | 0.9996 | CMDTYP | 0.944 | 0.8088 | 1.0103 | 0 | 0 | 0.224 | 0.47 | 2 | 3 | 4 |
| | (20 deg) | | PMAX | 0.995 | 1.0469 | 0.729 | 0 | 0 | -0.370 | 0.78 | 2 | 3 | 4 |
| | | | PLT | 0.999 | 1.1252 | 0.7116 | 0 | 0 | -0.474 | | | | |
| 3 | TCLMAX | 0.9975 | CMDTYP | 1.000 | 0.9973 | 1.1603 | 0 | 0 | 0.152 | 3.41 | 3 | 1 | 3 |
| | | | PMAX | 0.737 | 1.0892 | 1.0517 | 0 | 0 | -0.035 | 0.79 | 4 | 3 | 4 |
| | | | PLT | 0.861 | 1.0979 | 1.0501 | 0 | 0 | -0.045 | | | | |
| 4 | QD0AVG | 0.1021 | CMDTYP | 0.187 | 98.759 | 95.665 | 0 | 0 | -0.032 | 0.71 | 4 | 3 | 4 |
| | (0.25 sec) | | PMAX | 0.088 | 96.674 | 98.129 | 0 | 0 | 0.015 | 0.33 | 4 | 3 | 4 |
| | | | PLT | 0.262 | 94.981 | 99.338 | 0 | 0 | 0.045 | | | | |
| 5 | QDXSEC | 0.9999 | CMDTYP | 0.832 | 152.44 | 166.88 | 0 | 0 | 0.091 | 0.17 | 4 | 3 | 4 |
| | (0.25 sec) | | PMAX | 0.534 | 162.53 | 154.95 | 0 | 0 | -0.048 | 0.09 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 117.22 | 194.46 | 0 | 0 | 0.528 | | | | |
| 6 | QDMAX | 0.9999 | CMDTYP | 0.919 | 175.15 | 188.49 | 0 | 0 | 0.073 | 0.22 | 4 | 3 | 4 |
| | | | PMAX | 0.794 | 176.96 | 186.35 | 0 | 0 | 0.052 | 0.16 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 150.24 | 207.52 | 0 | 0 | 0.329 | | | | |
| 7 | TQDMAX | 0.3724 | CMDTYP | 0.240 | 0.2742 | 0.2649 | 0 | 0 | -0.035 | 0.27 | 4 | 3 | 4 |
| | | | PMAX | 0.214 | 0.2661 | 0.2744 | 0 | 0 | 0.031 | 0.24 | 4 | 3 | 4 |
| | | | PLT | 0.738 | 0.2888 | 0.2539 | 0 | 0 | -0.129 | | | | |
| 8 | QMAX | 0.9999 | CMDTYP | 1.000 | 56.428 | 47.718 | 0 | 0 | -0.168 | 1.16 | 3 | 2 | 4 |
| | | | PMAX | 0.987 | 51.646 | 53.371 | 0 | 0 | 0.033 | 0.23 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 48.374 | 55.873 | 0 | 0 | 0.145 | | | | |
| 9 | TQMAX | 0.9922 | CMDTYP | 1.000 | 0.6896 | 0.5285 | 0 | 0 | -0.269 | 6.44 | 2 | 1 | 2 |
| | | | PMAX | 0.244 | 0.6199 | 0.6108 | 0 | 0 | -0.015 | 0.35 | 4 | 3 | 4 |
| | | | PLT | 0.541 | 0.6297 | 0.6039 | 0 | 0 | -0.042 | | | | |
| 10 | QXSEC | 0.9985 | CMDTYP | 0.949 | 50.665 | 46.913 | 0 | 0 | -0.077 | 0.38 | 4 | 3 | 4 |
| | (0.5 sec) | | PMAX | 0.347 | 48.558 | 49.403 | 0 | 0 | 0.017 | 0.08 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 43.653 | 53.424 | 0 | 0 | 0.203 | | | | |
| 11 | AOADMX | 0.9999 | CMDTYP | 1.000 | 50.116 | 42.931 | 0 | 0 | -0.155 | 1.16 | 3 | 2 | 4 |
| | | | PMAX | 0.947 | 46.237 | 47.515 | 0 | 0 | 0.027 | 0.20 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 43.45 | 49.677 | 0 | 0 | 0.134 | | | | |
| 12 | TADMAX | 0.9814 | CMDTYP | 0.999 | 0.6665 | 0.5194 | 0 | 0 | -0.252 | 2.33 | 2 | 1 | 2 |
| | | | PMAX | 0.101 | 0.6007 | 0.5972 | 0 | 0 | -0.006 | 0.05 | 4 | 3 | 4 |
| | | | PLT | 0.912 | 0.6342 | 0.5693 | 0 | 0 | -0.108 | | | | |
| 13 | ADXSEC | 0.9991 | CMDTYP | 0.978 | 45.875 | 41.903 | 0 | 0 | -0.091 | 0.45 | 4 | 3 | 4 |
| | (0.5 sec) | | PMAX | 0.268 | 43.79 | 44.367 | 0 | 0 | 0.013 | 0.06 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 39.309 | 48.07 | 0 | 0 | 0.203 | | | | |
| 14 | NZMAX | 0.9999 | CMDTYP | 1.000 | 3.2217 | 3.1624 | 0 | 0 | -0.019 | 0.55 | 4 | 3 | 4 |
| | | | PMAX | 0.882 | 3.187 | 3.2035 | 0 | 0 | 0.005 | 0.15 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 3.1358 | 3.2443 | 0 | 0 | 0.034 | | | | |
| 15 | TNZMAX | 0.9992 | CMDTYP | 1.000 | 1.0511 | 1.2376 | 0 | 0 | 0.164 | 4.05 | 3 | 1 | 3 |
| | | | PMAX | 0.647 | 1.1507 | 1.1199 | 0 | 0 | -0.027 | 0.67 | 4 | 3 | 4 |
| | | | PLT | 0.855 | 1.1615 | 1.1155 | 0 | 0 | -0.040 | | | | |
| 16 | NZDMAX | 0.9999 | CMDTYP | 0.880 | 4.7856 | 4.5529 | 0 | 0 | -0.050 | 0.16 | 4 | 3 | 4 |
| | | | PMAX | 0.700 | 4.7478 | 4.5975 | 0 | 0 | -0.032 | 0.10 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 3.9277 | 5.3146 | 0 | 0 | 0.307 | | | | |
| 17 | TNZDMX | 0.6051 | CMDTYP | 0.640 | 0.3857 | 0.3512 | 0 | 0 | -0.094 | 1.07 | 4 | 2 | 4 |
| | | | PMAX | 0.734 | 0.3892 | 0.3472 | 0 | 0 | -0.114 | 1.30 | 4 | 2 | 4 |
| | | | PLT | 0.616 | 0.3524 | 0.3847 | 0 | 0 | 0.088 | | | | |
| 18 | THTMAX | 0.9999 | CMDTYP | 0.988 | 35.239 | 32.575 | 0 | 0 | -0.079 | 0.75 | 4 | 3 | 4 |
| | | | PMAX | 1.000 | 30.1 | 38.649 | 0 | 0 | 0.253 | 2.41 | 2 | 1 | 2 |
| | | | PLT | 0.998 | 32.102 | 35.639 | 0 | 0 | 0.105 | | | | |
| 19 | TTHTMX | 0.9999 | CMDTYP | 0.186 | 1.0434 | 1.0376 | 0 | 0 | -0.006 | 0.09 | 4 | 3 | 4 |
| | | | PMAX | 1.000 | 0.9353 | 1.1654 | 0 | 0 | 0.222 | 3.69 | 2 | 1 | 2 |
| | | | PLT | 0.976 | 1.007 | 1.0693 | 0 | 0 | 0.060 | | | | |

| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20 | AOAMX | 0.9999 | CMDTYP | 1.000 | 70.057 | 116.22 | 0 | 0 | 0.528 | 45.67 | 1 | 1 | 1 |
| | | | PMAX | 0.860 | 90.977 | 91.5 | 0 | 0 | 0.006 | 0.50 | 4 | 3 | 4 |
| | | | PLT | 0.798 | 90.646 | 91.7 | 0 | 0 | 0.012 | | | | |
| 21 | TAOAMX | 0.9999 | CMDTYP | 1.000 | 7.755 | 4.224 | 0 | 0 | -0.646 | 12.61 | 1 | 1 | 1 |
| | | | PMAX | 0.507 | 6.1584 | 6.1108 | 0 | 0 | -0.008 | 0.15 | 4 | 3 | 4 |
| | | | PLT | 0.988 | 6.307 | 5.9924 | 0 | 0 | -0.051 | | | | |
| 22 | AOAXSEC | 0.9807 | CMDTYP | 0.999 | 41.35 | 36.606 | 0 | 0 | -0.122 | 2.66 | 3 | 1 | 3 |
| | (1.0 sec) | | PMAX | 0.532 | 38.766 | 39.659 | 0 | 0 | 0.023 | 0.50 | 4 | 3 | 4 |
| | | | PLT | 0.866 | 38.203 | 39.998 | 0 | 0 | 0.046 | | | | |
| 24 | TAOA50 | 0.9999 | CMDTYP | 1.000 | 1.3011 | 1.583 | 0 | 0 | 0.197 | 4.91 | 3 | 1 | 3 |
| | | | PMAX | 0.777 | 1.4507 | 1.4063 | 0 | 0 | -0.031 | 0.77 | 4 | 3 | 4 |
| | | | PLT | 0.905 | 1.4615 | 1.4039 | 0 | 0 | -0.040 | | | | |
| 27 | TCMPLT | 0.9999 | CMDTYP | 1.000 | 8.4704 | 4.224 | 0 | 0 | -0.753 | 473.51 | 1 | 1 | 1 |
| | | | PMAX | 1.000 | 6.3007 | 6.7881 | 0 | 0 | 0.075 | 46.88 | 4 | 1 | 4 |
| | | | PLT | 0.269 | 6.5297 | 6.5193 | 0 | 0 | -0.002 | | | | |
| 30 | PMAXACT | 0.9999 | CMDTYP | 0.942 | 60.449 | 62.181 | 0 | 0 | 0.028 | 0.51 | 4 | 3 | 4 |
| | | | PMAX | 1.000 | 74.373 | 45.725 | 0 | 0 | -0.506 | 9.20 | 1 | 1 | 1 |
| | | | PLT | 0.998 | 63.07 | 59.696 | 0 | 0 | -0.055 | | | | |
| 31 | TPMAX | 0.9999 | CMDTYP | 1.000 | 1.1819 | 1.4103 | 0 | 0 | 0.178 | 0.92 | 3 | 3 | 4 |
| | | | PMAX | 1.000 | 1.4199 | 1.129 | 0 | 0 | -0.231 | 1.20 | 2 | 2 | 3 |
| | | | PLT | 1.000 | 1.4206 | 1.1732 | 0 | 0 | -0.193 | | | | |
| 32 | PDMAX | 0.9999 | CMDTYP | 1.000 | 128.53 | 92.728 | 0 | 0 | -0.332 | 4.12 | 2 | 1 | 2 |
| | | | PMAX | 1.000 | 141.66 | 77.214 | 0 | 0 | -0.645 | 8.00 | 1 | 1 | 1 |
| | | | PLT | 0.741 | 117.02 | 107.97 | 0 | 0 | -0.081 | | | | |
| 33 | TPDMAX | 0.9447 | CMDTYP | 0.346 | 0.2434 | 0.2239 | 0 | 0 | -0.083 | 2.21 | 4 | 1 | 4 |
| | | | PMAX | 0.972 | 0.2815 | 0.179 | 0 | 0 | -0.468 | 12.38 | 1 | 1 | 1 |
| | | | PLT | 0.177 | 0.2297 | 0.2386 | 0 | 0 | 0.038 | | | | |
| 36 | PS | 0.9999 | CMDTYP | 1.000 | -154.1 | -186.4 | 0 | 0 | -0.192 | 5.54 | 3 | 1 | 3 |
| | | | PMAX | 1.000 | -184.5 | -150.4 | 0 | 0 | 0.206 | 5.95 | 2 | 1 | 2 |
| | | | PLT | 0.840 | -172.1 | -166.2 | 0 | 0 | 0.035 | | | | |
| 37 | ENERGY | 0.9999 | CMDTYP | 1.000 | -3012 | -2039 | 0 | 0 | 0.400 | 47.64 | 1 | 1 | 1 |
| | | | PMAX | 0.970 | -2578 | -2552 | 0 | 0 | 0.010 | 1.19 | 4 | 2 | 4 |
| | | | PLT | 0.947 | -2554 | -2576 | 0 | 0 | -0.008 | | | | |
| 38 | VDOTMX | 0.9069 | CMDTYP | 0.327 | -27.33 | -27.62 | 0 | 0 | -0.010 | 0.33 | 4 | 3 | 4 |
| | | | PMAX | 0.899 | -26.93 | -28.09 | 0 | 0 | -0.042 | 1.33 | 4 | 2 | 4 |
| | | | PLT | 0.784 | -26.99 | -27.86 | 0 | 0 | -0.032 | | | | |
| 39 | DELV | 0.9999 | CMDTYP | 1.000 | -79.24 | -73.27 | 0 | 0 | 0.078 | 2.63 | 4 | 1 | 4 |
| | | | PMAX | 1.000 | -73.92 | -79.56 | 0 | 0 | -0.074 | 2.47 | 4 | 1 | 4 |
| | | | PLT | 0.999 | -75.27 | -77.54 | 0 | 0 | -0.030 | | | | |
| 46 | PXSEC | 0.9999 | CMDTYP | 0.011 | 59.447 | 59.463 | 0 | 0 | 0.000 | 0.01 | 4 | 3 | 4 |
| | (1.0 sec) | | PMAX | 1.000 | 71.542 | 45.169 | 0 | 0 | -0.476 | 15.89 | 1 | 1 | 1 |
| | | | PLT | 0.841 | 60.421 | 58.637 | 0 | 0 | -0.030 | | | | |
| 47 | PDXSEC | 0.9991 | CMDTYP | 0.593 | 83.13 | 78.28 | 0 | 0 | -0.060 | 1.92 | 4 | 2 | 4 |
| | (0.5 sec) | | PMAX | 1.000 | 97.071 | 61.804 | 0 | 0 | -0.467 | 14.93 | 1 | 1 | 1 |
| | | | PLT | 0.302 | 82.28 | 79.746 | 0 | 0 | -0.031 | | | | |

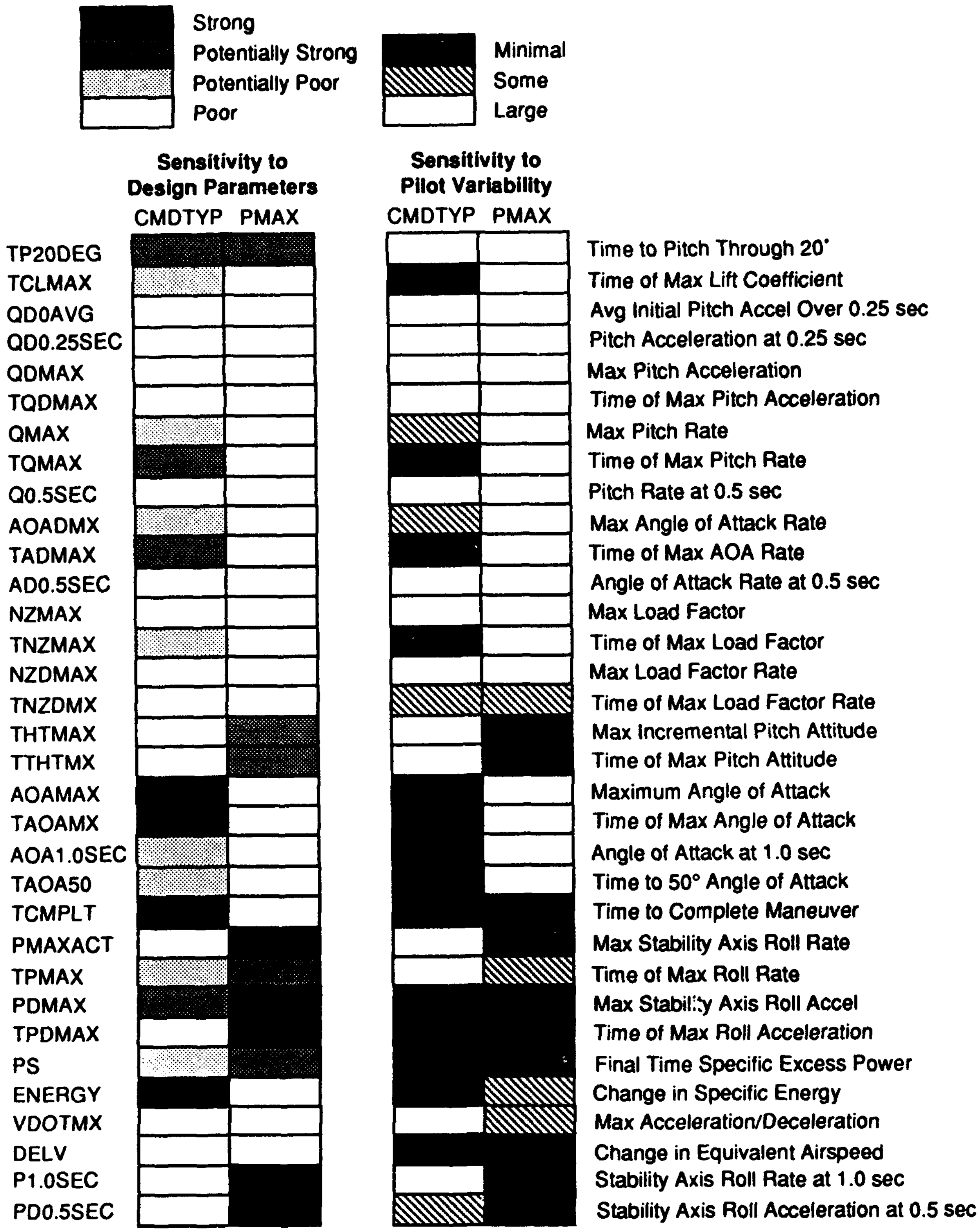
## STEM 17 ANALYSIS B



## STEM 17 ANALYSIS B



STEM 17 ANALYSIS B



STEM 17 ANALYSIS B

- Strong
- Potentially Strong
- Potentially Poor
- Poor

**Overall Sensitivity**

| | CMDTYP | PMAX | |
|---|---|---|---|
| TP20DEG | Poor | Poor | Time to Pitch Through 20° |
| TCLMAX | Potentially Poor | Poor | Time of Max Lift Coefficient |
| QD0AVG | Poor | Poor | Avg Initial Pitch Accel Over 0.25 sec |
| QD0.25SEC | Poor | Poor | Pitch Acceleration at 0.25 sec |
| QDMAX | Poor | Poor | Max Pitch Acceleration |
| TQDMAX | Poor | Poor | Time of Max Pitch Acceleration |
| QMAX | Poor | Poor | Max Pitch Rate |
| TQMAX | Potentially Strong | Poor | Time of Max Pitch Rate |
| Q0.5SEC | Poor | Poor | Pitch Rate at 0.5 sec |
| AOADMX | Poor | Poor | Max Angle of Attack Rate |
| TADMAX | Potentially Strong | Poor | Time of Max AOA Rate |
| AD0.5SEC | Poor | Poor | Angle of Attack Rate at 0.5 sec |
| NZMAX | Poor | Poor | Max Load Factor |
| TNZMAX | Potentially Poor | Poor | Time of Max Load Factor |
| NZDMAX | Poor | Poor | Max Load Factor Rate |
| TNZDMX | Poor | Poor | Time of Max Load Factor Rate |
| THTMAX | Poor | Potentially Strong | Max Incremental Pitch Attitude |
| TTHTMX | Poor | Potentially Strong | Time of Max Pitch Attitude |
| AOAMAX | Strong | Poor | Maximum Angle of Attack |
| TAOAMX | Strong | Poor | Time of Max Angle of Attack |
| AOA1.0SEC | Potentially Poor | Poor | Angle of Attack at 1.0 sec |
| TAOA50 | Potentially Poor | Poor | Time to 50° Angle of Attack |
| TCMPLT | Strong | Poor | Time to Complete Maneuver |
| PMAXACT | Poor | Strong | Max Stability Axis Roll Rate |
| TPMAX | Poor | Potentially Poor | Time of Max Roll Rate |
| PDMAX | Potentially Strong | Strong | Max Stability Axis Roll Accel |
| TPDMAX | Poor | Strong | Time of Max Roll Acceleration |
| PS | Potentially Poor | Potentially Strong | Final Time Specific Excess Power |
| ENERGY | Strong | Poor | Change in Specific Energy |
| VDOTMX | Poor | Poor | Max Acceleration/Deceleration |
| DELV | Poor | Poor | Change in Equivalent Airspeed |
| P1.0SEC | Poor | Strong | Stability Axis Roll Rate at 1.0 sec |
| PD0.5SEC | Poor | Strong | Stability Axis Roll Acceleration at 0.5 sec |

STEM 17
PILOT F
LONGITUDINAL CONFIGURATION 304
LATERAL CONFIGURATION 202

It's got a real comfortable onset rate of both pitch and roll. Real rapid entry. A fairly controllable stop. In other words, I did have too use full deflection cross control to stop this configuration, but it would stop. About half way, or maybe about 90 degrees through the slice, maybe approaching 30 to 45 degrees of pure vertical down, I just crossed control the opposite way and it seemed to stop at the center line. In other words, it wasn't too sloppy but it did take full deflection at that rate. Full counter control deflection at that rate to stop it.

STEM 17
PILOT H
LONGITUDINAL CONFIGURATION 304
LATERAL CONFIGURATION 202

A little overshoot on that one. I am coming off the roll a little bit too late and overshooting the 180 degree change. If I use a little lead, it felt real controllable, real quick. Not very disorienting at all from my perspective. That felt pretty good. When I go full right aft stick, the nose comes up and then it stops and you get the big yaw rate going and actually have to take out the roll probably about 30 degrees prior. And from then on it's real easy just to hold the heading and pull straight out. I had to lead taking out the roll to stop on your heading. Other than that it seemed fairly controllable. That seemed very simple to do in this configuration.

STEM 17
PILOT F
LONGITUDINAL CONFIGURATION 305
LATERAL CONFIGURATION 202

Boy, that one came through real tight. I think that one's quicker than the other one (Longitudinal configuration 304, lateral configuration 202). At least on the entry. It seems to me like the lateral roll capability was more aggressive so I'd come around rapidly to a nose low position and it required a very aggressive cross control to stop it. A couple of times I overshot the runway. Then the pitch rate to get it back up to level flight seemed about the same as the other configuration but the pitch onset and the roll rate seemed to be higher. And the resulting maneuver more dynamic, a little quicker.

STEM 17
PILOT H
LONGITUDINAL CONFIGURATION 305
LATERAL CONFIGURATION 202

That one seemed nice. The nose ended up pretty much 90 degrees straight down. I didn't get the nose too high before I started the roll. It is fairly easy to control the heading change. That time I used about half lateral stick in the opposite direction to stop the roll. I started the check about 30 to 40 degrees before desired heading. It seemed to work out

okay. That seemed real easy to control too. If you wait until you see the runway at 180 you are definitely going to overshoot it 20 or 30 degrees. But it is fairly easy to compensate for and avoid the overshoot. Yeah, I put the opposite stick in for about 1-1/2 potatoes, back to the center, and it seemed to roll out right on the runway.

STEM 17
PILOT F
LONGITUDINAL CONFIGURATION 304
LATERAL CONFIGURATION 203

Well, it's an obviously slow roll rate. It seems like the pitch rate is slower also. Just very slow in the roll capability. And when I get to the bottom it's not all that easy to stop either. It seems like it requires a pretty aggressive cross control to control the nose after the rate has built up. It seems like it takes pretty aggressive cross control input or reverse input to stop it.

STEM 17
PILOT H
LONGITUDINAL CONFIGURATION 304
LATERAL CONFIGURATION 203

A lot higher nose on the initial pull and a lot slower yaw rate. I'm already close to 80 to 85 degrees nose down when I finish the roll. The nose is going up a lot higher and we're getting a lot slower tracking across the sky coming down. It doesn't really want to roll. This one is a lot easier to roll out on the runway heading though. When I take out the roll control it pretty much stops, so I don't have to lead it as much as the last one (Longitudinal configuration 305, lateral configuration 202). It does not require a lot of compensation to get on the heading, but it just doesn't seem like it's happening as fast as the other ones. Definitely a slow up of the yaw rate. Again you can see the nose goes up a little bit higher than the one before. I get the yaw rate coming along nicely and ended up about 90 degrees of bank and it just kind of tops out and the nose falls slowly through and it's easier to roll out of the heading. But it's not quite as quick.

STEM 17
PILOT F
LONGITUDINAL CONFIGURATION 305
LATERAL CONFIGURATION 203

Slow roll rate. I'm again reluctant to say anything about the pitch. Maybe the two are combined but it appears to me to be a slow roll rate compared to the other ones and it's not incredibly difficult to stop at the bottom but it does require full opposite control. It doesn't stop moving until full controls have been applied for maybe a half a second. So I'm having to saturate the controls for a period of time to stop the motion. I'd say my nose is maybe 25 degrees off the center line of the runway when I put the opposite control in.

STEM 17
PILOT H
LONGITUDINAL CONFIGURATION 305
LATERAL CONFIGURATION 203

Everything on this one is moving a lot slower. The initial pitch rate seems a lot slower and the roll rate seems a lot slower. Seems like it's kind of going in slow motion. It is fairly easy to control though. I think I got 90 degrees nose down. I didn't have to compensate too much to roll out on the heading. It has fairly decent heading control for the end game. This one seems kind of sluggish. Nose seems to go up a little bit higher than the ones previous but kind of a slower yaw rate and heading control at the end was fairly easy. Not too much compensation required there.

STEM 17
PILOT F
LONGITUDINAL CONFIGURATION 712
LATERAL CONFIGURATION 202

A little sloppy overshoot in roll. I think this sets the world record for this event. That one is real squirrley. Very, very rapid entry and very difficult to control through the bottom. Instead of trying to cross control to stop it, I just sort of eased off the back pressure and went into an aft stick pull so I sort of slid into the vertical. On the other ones I would just do a roll to hit the runway and then pull aft stick and this one, every time I tried to stop on the runway, I would overshoot it. So I started bleeding out the back pressure and cross control before I got there but then I'd be putting in back stick because I was already at 90 low so the whole thing is a curvilinear approach to coming back to wings level horizon instead of rolling 90, stopping on the runway, and putting aft stick in. Very quick. Sort of like slinging the airplane around. It felt like if I'd have to track something at the end of it, it would have been very difficult.

STEM 17
PILOT H
LONGITUDINAL CONFIGURATION 712
LATERAL CONFIGURATION 202

That's some serious pitch rate. The roll seemed pretty quick, pretty nice. I definitely had to lead the lateral stick check by about 40 to 30 degrees. I would say that it's mildly disorienting. You feel a little bit behind. Not sure you can catch up to it. It definitely feels like everything is happening a lot quicker. The nose is coming up quicker. You're not hanging out nose down on the runway, that's for sure. You can definitely get yourself turned around in a hurry. Everything happens a lot faster. The yaw rate feels like it's very fast. I don't think I'm getting to 90 degrees nose-down pitch on those either. I think we're already up to 50 or 60 degrees by the time I have captured the heading. It didn't seem like we were getting to be nose down because we're just moving too fast. But I would think that this would be tactically advantageous. The pitch rate is very fast. I have one correction at the bottom you can make and then his nose is already coming through the horizon. I was getting fairly close to the runway. Plus or minus 10 degrees I'd say.

STEM 17
PILOT F
LONGITUDINAL CONFIGURATION 712
LATERAL CONFIGURATION 203

We've got some alpha on that one in a hurry. I get the feeling the angle of attack is building up so quick that I'm not going to get my nose down to 90. It's going to be almost like a helicopter attack turn. I'm rolling, but my nose has already come through a 180 heading before it ever gets to the 90 nose-low. I don't think I get any more than about 40 degrees nose-low on that.

STEM 17
PILOT H
LONGITUDINAL CONFIGURATION 712
LATERAL CONFIGURATION 203

By the time I get to runway heading I was probably already 40 degrees nose up. Lots of alpha on that one. So that's even more pitch rate, more alpha available on that one than the other ones. I am not even pointing towards the ground much on that. Almost a 180 turn without going vertical. The nose barely drops below the horizon. I'm probably 30 to 40 degrees nose down and pitching up by the time I get to 180, so the nose is definitely not going to 90 degrees down anymore. Basically, you are almost turned around before you know it. This feels really a lot like a slice turn where it's mostly pitch and just a little bit of roll. It is easy to control though. I don't seem to have any problems with that. It didn't seem very disorienting either. It seemed fairly easy to follow what's going on. Decent roll control. I didn't have to lead it too much to stop it. Just take it out and boom. Piece of cake. The heading control on that was fairly easy.

## Data Contents for STEM 18: Tanker Boom Tracking

TEST 1: Generic Fighter Testing
- Summary of Design Parameter Variations Tested
- Pilot Comments

TEST 2: Generic Transport Testing
- Summary of Design Parameter Variations Tested
- Pilot Comments

## Summary of Design Parameters Tested for STEM 18 TEST 1

Test variables:
CAP: Control Anticipation Parameter, also results in a variation in short period frequency
(-) 0.3
(+) 0.6
(++) 0.82

ZSP: Short period damping
(-) 0.5
(+) 0.9

TR: Roll mode time constant
(-) 0.5 sec
(+) 0.3 sec

### Test Matrix

| Lon Config | Lat Config | CAP | ZSP | TR |
|---|---|---|---|---|
| 318 | 216 | 0.82 (++) | 0.9 (+) | 0.3 (+) |
| 301 | 216 | 0.60 (+) | 0.9 (+) | 0.3 (+) |
| 300 | 216 | 0.30 (-) | 0.9 (+) | 0.3 (+) |
| 303 | 216 | 0.60 (+) | 0.5 (-) | 0.3 (+) |
| 318 | 200 | 0.82 (++) | 0.9 (+) | 0.5 (-) |

STEM 18 TEST 1
PILOT G
LONGITUDINAL CONFIGURATION 318
LATERAL CONFIGURATION 216
CHR 3
PIO -

I'm doing a much better job of controlling this. I am definitely not quite as PIO prone as our earlier one since I am so close. Shoot, I'm real close and almost tracking the thing. It's kind of hard to tell the range. I can keep the pipper inside the boom. I'd say I can easily do that 50 percent of the time. It's probably a good idea that I should only rate when I'm very near the desired range for rating because the mil criteria is range dependent. I find that overall I've become very stable. I've tried to stay fairly open loop, though. Very small inputs are required. It's pretty stable, as far as keepingkeeping that wing tip in there. I can easily do it almost 100 percent of the time within the 30 mil redical. There is a little PIO developing here, but not much. Overall, initially it may be a little bit pitch sensitive but I think I compensated for that, trying to stay very open loop. It is definitely controllable. Adequate performance is easily attained. It is satisfactory without improvement. I don't think I've flown anything much better in this sim. There is some pilot compensation going on. As far as trying to quantify it I'd say it's trying to be a little more open loop. You have to really keep your inputs low to maintain tracking. The recorrections were very smooth also. Once again I kept the input small. I think the airplane was overall very predictable. In fact, if we came up with some kind of correction scale as far as, changing aim point within a desired time or something like that, I would say that I'd probably go up another rating. I thought the acquisition was not that difficult.

STEM 18 TEST 1
PILOT G
LONGITUDINAL CONFIGURATION 301
LATERAL CONFIGURATION 216
CHR 3
PIO -

I'm easily maintaining it within a 30 mil circle. I am getting the axial PIO here a little bit. It seems like I'm a little more PIO prone at 135 ft range. It's not that difficult to track. I am getting a lot of mil-to-idle stuff here. Drifting off a little bit laterally but that's kind of more as I worry about my closure. I'm going to try going up to a wing tip. Overall it is just slightly more PIO prone in pitch but it seems like but still pretty easy to track. I'm still easily meeting desired performance. It's good and stable open-loop, that's for sure. When I go closed-loop, start driving up and gaining on the tanker, and start getting a little close then I start getting the PIOs. But if I'm going to rate it at 150 ft, which is where I ought to be rating it, I don't think I'm going to find that much difference between the two. It was very controllable, and adequate performance was attainable. I'd say it's even satisfactory without improvement. I'm having a tough time on these between good, negligible deficiencies or fair, some mildly unpleasant deficiencies. I keep wanting to say fair, some mildly unpleasant deficiencies but I can't define my deficiencies. It's just such a high workload task that you have to work at it, probably no matter how good the airplane is. I'll still say it's minimal pilot compensation required. You got to stay fairly open

loop. It does seem maybe a little bit more pitch sensitive than the previous one (Longitudinal configuration 318), but at 150 feet it's fairly stable.

STEM 18 TEST 1
PILOT G
LONGITUDINAL CONFIGURATION 300
LATERAL CONFIGURATION 216
CHR 4
PIO -

A lot more PIO here than previous ones (Longitudinal configurations 318 and 301). I'd say this has not been stable as previous configurations . I am still meeting desired performance. This seems a little jerky in roll. It was definitely controllable and adequate performance is obtainable but it's definitely not satisfactory without improvement. You really have to work to get the desired performance. A lot tighter control is required and it leads to a little bit more PIO, particularly in pitch. And one thing I don't think really impacted the tracking was the lateral dynamics, although I did note they seemed to be quicker responding than the previous.

STEM 18 TEST 1
PILOT G
LONGITUDINAL CONFIGURATION 303
LATERAL CONFIGURATION 216
CHR 5
PIO -

This is a touchy one. I mean it was touchy way out here. Very touchy in pitch. It's much too quick for this task. The roll is a little quick, too. But I kind of characterized the other one as being a little more jerky. It's kind of funny, I noticed that this thing is worse farther out. I seem to be doing somewhat reasonable in here but now I'm going to start thinking about my criteria, and I'm not doing nearly as good a job as I was before. I seem to be tracking fairly reasonably. It has a quick roll response and very quick pitch response. There we go. I'm driving up my gain, which is probably a problem I've had on the previous ones as far as not trying to track a point as closely as I should. That was just trying to keep the pipper on a point, and I'll try to keep the 30 mil radical.This is definitely wobbling around a little bit more. A little more difficult laterally. Trying to limit my throttle movements here. I feel like I've had to work harder on this configuration than any of the others. I am having a little trouble laterally keeping it on. It was controllable. It is adequate. It is not satisfactory. I think I'm approaching adequate more than desired performance. I tend to drift, especially laterally, out of the 30 mil redical. I think adequate performance is requiring considerable pilot compensation. I feel overall the configuration is more sensitive in pitch and sensitive in yaw. But it's funny that I noticed the pitch further away from the boom than when I got in close. I guess I backed off some of my gain when I got in close.

STEM 18 TEST 1
PILOT G
LONGITUDINAL CONFIGURATION 318
LATERAL CONFIGURATION 200
CHR 5
PIO -

I do have a little bit of lateral PIO although I don't feel like it's got a overly quick roll or anything. Probably if anything maybe an overly sluggish roll. I'll tend to drift off and have trouble getting back on or drift off the other direction. I'm definitely having some lateral problems with this one. It's almost like this has become more of a lateral tracking task. It is controllable. Adequate performance is attainable. It is a tolerable workload but it's definitely not satisfactory without improvement. I would tend more towards adequate versus desired performance. A lot of that was lateral. It just seemed slow if anything. I would make a correction and the airplane seemed to respond a little bit slow and be kind of out of phase as far as my lateral inputs. The pitch wasn't exactly perfect either but my hardest time was laterally. I would say it was considerable and not extensive compensation. I also would add the caveat that pilot fatigue may have affected that last run, more so than the others.

## Summary of Design Parameters Tested for STEM 18 TEST 2

Test variables:

CAP: Control Anticipation Parameter, also results in a variation in short period frequency
- (-) 0.15
- (+) 0.3

ZSP: Short period damping
- (-) 0.5
- (+) 0.9

TR: Roll mode time constant
- (-) 1.0 sec
- (+) 0.5 sec

LONSNS: Longitudinal stick sensitivity
- (-) 3.28 deg AOA/in longitudinal stick
- (+) 5.0 deg AOA/in longitudinal stick

LATSHP: Parabolic lateral stick shaping
- (-) off, linear command gradient
- (+) on, parabolic gradient with reduced tracking sensitivity

### Test Matrix

| Lon Config | Lat Config | CAP | ZSP | TR | LONSNS | LATSHP |
|---|---|---|---|---|---|---|
| 501* | 400 | 0.15 (-) | 0.9 (+) | 0.5 (+) | 5.0 (+) | off (-) |
| 500* | 400 | 0.30 (+) | 0.9 (+) | 0.5 (+) | 5.0 (+) | off (-) |
| 500* | 401 | 0.30 (+) | 0.9 (+) | 1.0 (-) | 5.0 (+) | off (-) |
| 502 | 400 | 0.30 (+) | 0.5 (-) | 0.5 (+) | 3.28 (-) | off (-) |
| 500 | 400 | 0.30 (+) | 0.9 (+) | 0.5 (+) | 3.28 (-) | off (-) |
| 503 | 400 | 0.30 (+) | 0.5 (-) | 0.5 (+) | 3.28 (-) | off (-) |
| 500 | 400* | 0.30 (+) | 0.9 (+) | 0.5 (+) | 3.28 (-) | on (+) |

STEM 18 TEST 2 (Transport Aircraft Testing)
PILOT I
LONGITUDINAL CONFIGURATION 501*
LATERAL CONFIGURATION 400
CHR 7
PIO 4

I am seeing that little bit of a cyclic PIO. I was keeping desired performance for about the first 10 seconds and now I think I am in a cycle within the adequate criteria. And things aren't getting better. They are really getting worse, actually. I just basically don't feel like I can stop the pitch PIO and there it is outside of the adequate criteria. Yes, it is controllable. Is adequate performance attainable? No. The lateral is not my major concern. I didn't feel like it was causing the deviations that the pitch control was. I felt like the pitch had too much lag. I would be trying to correct, let's say go down, and I would keep really pushing on the stick--probably about 3 inches a push--and I would see very little response out of the airplane. And by the time I saw the response out of the airplane, the tanker again is coming out. So now I am just cycling between 2 and 3 inches forward and aft on the stick.

STEM 18 TEST 2 (Transport Aircraft Testing)
PILOT I
LONGITUDINAL CONFIGURATION 500*
LATERAL CONFIGURATION 400
CHR 4
PIO 3

The airplane seems to be flying better than it was (Longitudinal configuration 501*) in the pitch. Because now I am keeping the pipper on the boom fairly well with a little bit of PIO tendency. There is a little bit of a deviation. There is a little bit of a lateral. This is a better flight control system. I can maintain the performance within the adequate with a slight PIO tendency. Especially with any type of inattention towards the other numbers on the HUD, here is a little bit of a lateral PIO. Okay, out here at 240 ft the airplane is real nicely controllable. Right within the desired criteria. Right as I hit 200 ft I get a little bit of a pitch PIO tendency there. Even on this one in at 170 ft you get a pretty good PIO. It is controllable though. I have adequate performance on this. I saw very little deviations outside of the 50 mil ring even when I got in close. Is it satisfactory without improvement? I am going to say a no because of the slight PIO I am getting in there. That kind of shakes my confidence from moving into the contact position. So I am going to say we are up here at the desired performance requires moderate pilot compensation, because the PIO is not bad. There was a slight tendency for PIO's. I had a little bit of overshoot there in the reposition task. Although it has dampened out pretty well. There is a little bit of lateral overshoot. Especially when I try to really aggressively track the wing tip I get into both the pitch and lateral oscillation. I think the control harmony on the roll is what is causing that. The pitch forces seem a little laggy to me and the roll response is very responsive. I feel like I am having to make fairly aggressive movements with the pitch stick to get the movement that I want. And that is causing me to make slight deviations in the lateral when I did not mean to and since the lateral qualities are a little bit responsive.

STEM 18 TEST 2 (Transport Aircraft Testing)
PILOT I
LONGITUDINAL CONFIGURATION 500*
LATERAL CONFIGURATION 401
CHR 7
PIO 4

I have got pretty much of a divergent lateral PIO there out at about 240 feet. If I kept the performance that would drive me into a divergent PIO. The only way I can get out of it is by backing out and looking at the whole airplane. I think you guys have decreased my gain in the roll here, but that is just causing a real lag problem. This one just gets me incredibly out of phase when I look at the boom bi-laterally, pitch wise it is nice. It is controllable, yes. Almost a divergent PIO, but we will call it a yes there. Is adequate performance obtainable? No, because of the lateral PIO. Control is not in question, it is really a matter of the performance parameters. I didn't feel like I could prevent the lateral oscillations. I have to reduce the gain or abandon the task to get rid of the PIO's.

STEM 18 TEST 2 (Transport Aircraft Testing)
PILOT I
LONGITUDINAL CONFIGURATION 502
LATERAL CONFIGURATION 400
CHR 3
PIO -

The fixed boom tracking is pretty nice. When I am in too close at 170 ft, I am starting to get a PIO, but when I am back at 200 ft it is pretty nice. The reposition is a real good maneuver here. It basically puts me into an overshoot situation and then a little bit of lateral PIO. I like the feel of this airplane the best so far. It has a nice little dead stick area. And when I don't want to make an input, I pretty much can just leave the airplane and it will stay there or I can stir the stick a little and it feels pretty nice in my hand. And the airplane doesn't move around. It still has a little bit of a problem on the reposition. When I go to the reposition of the wing tip it is fairly difficult to acquire it right off the bat. I get a lateral pitch overshoot and then I get a slight lateral PIO. We might almost consider some overshoot criteria for the repositions to the wing tips. Basically when I get behind the boom, the pitch flying characteristics of this airplane are pretty nice. Here I am at 170 ft and on a couple of the others I haven't been able to fly in here without getting that pitch PIO. Here there it is a little bit. But it is certainly not divergent like some of the others. It is controllable. Is adequate performance available? Yes. Is it satisfactory without improvement? As far as the straight flying qualities out there at 200 ft and tracking the boom, I am going to say yes. I am not even going to rate the PIO on that because it wasn't really warranted.

STEM 18 TEST 2 (Transport Aircraft Testing)
PILOT I
LONGITUDINAL CONFIGURATION 500
LATERAL CONFIGURATION 400
CHR 3
PIO -

A little bit of PIO, but I am in kind of close, I am in at 160 ft. So I will back back out. I am trying to reposition up to the right. There is a big overshoot. This configuration flies nicely beyond 200 ft. On all of these it is difficult to do the reposition task and still maintain range. I am having a little problem stopping it where I want laterally on the repositions. I am now in here at 170 ft and I have a little PIO but not bad. The problem with the repositions is that they overtask me such that I can't monitor things as well. I invariably find myself changing range due to the reposition. Overall this configuration flies pretty good. Is it controllable? Yes. Is adequate performance attainable? Yes. Is it satisfactory without improvement. As far as the task of flying out there at 200 ft, I will say yes. The airplane flies really nicely when you are not trying to change anything, and requires minimal compensation on the repositions. I won't rate the PIO because I am not seeing it at 200 ft.

STEM 18 TEST 2 (Transport Aircraft Testing)
PILOT I
LONGITUDINAL CONFIGURATION 503
LATERAL CONFIGURATION 400
CHR 8
PIO 3

I seem to be getting some pitch PIO on the repositions when I am around 170 ft. I think it is due to a lag in the pitch response. I am getting a little bit of unwanted roll response. I had a little bit of an overshoot on that reposition and I had a little lateral PIO. I seem to have a pitch PIO problem on the repositions on this configuration. It is controllable. Is adequate performance obtainable with a tolerable pilot workload? No, because I am chasing that PIO. I am going to say considerable compensation. I can keep the adequate performance it feels like, but it is throughout that PIO. I am not given the confidence in any closer to the tanker.

STEM 18 TEST 2 (Transport Aircraft Testing)
PILOT I
LONGITUDINAL CONFIGURATION 500
LATERAL CONFIGURATION 400*
CHR 3
PIO -

The pitch response on this one is pretty nice. I am in here at 150 feet and I can actually control the pitch rather than getting in that PIO. I am feeling a little bit more a breakout in the lateral. I am just going to make a lateral reacquisition of the boom. Kind of a sliding over, sliding over, I am trying to stop it. That got me in a little bit of a PIO, but I am really close. As far as laterally, I am not getting the unwanted lateral inputs that I was getting out of one configuration that I really didn't like. But it is a fairly difficult to make real fine adjustments to the lateral. It feels like I am having to put in more stick than what I

think would be necessary. But it tracks pretty good out here at 150 ft. There is a repositioning and I don't get in to that lateral PIO on the reposition too much. It is controllable. Adequate performance is attainable. Is it satisfactory without improvement? This one is close, I am going to say yes. Minor compensation.

## Data Contents for STEM 19: Tracking in PA

TEST 1: Generic Fighter Testing

- Summary of Design Parameter Variations Tested
- Pilot Comments

TEST 2: Generic Transport Testing

- Summary of Design Parameter Variations Tested
- Pilot Comments

## Summary of Design Parameters Tested for STEM 19 TEST 1

Test variables:

WSP: Short period frequency at 100 KEAS. (Actual short period frequency was then scheduled linearly with airspeed)

- (-) 0.551 rad/sec, (at 100 KEAS)
- (+) 0.729 rad/sec, (at 100 KEAS)

ZSP: Short period damping

- (-) 0.4
- (+) 0.8

TR: Roll mode time constant

- (-) 1.0 sec
- (+) 0.5 sec

PMAX: Maximum attainable stability axis roll rate

- (-) 100 deg/sec
- (+) 150 deg/sec

### Test Matrix

| Lon Config | Lat Config | CAP | ZSP | TR | PMAX |
|---|---|---|---|---|---|
| 306 | 200 | 0.729 (+) | 0.8 (+) | 0.5 (+) | 150 (+) |
| 307 | 200 | 0.551 (-) | 0.8 (+) | 0.5 (+) | 150 (+) |
| 308 | 200 | 0.729 (+) | 0.4 (-) | 0.5 (+) | 150 (+) |
| 306 | 201 | 0.729 (+) | 0.8 (+) | 1.0 (-) | 150 (+) |
| 306 | 204 | 0.729 (+) | 0.8 (+) | 0.5 (+) | 100 (-) |

STEM 19 TEST 1
PILOT G
LONGITUDINAL CONFIGURATION 306
LATERAL CONFIGURATION 200
CHR 3

I have a little bit of difficulty during the turns with a little bit of a lateral oscillation around the velocity vector. It's overall pretty well behaved here. I can easily keep him with inside the 50 mil. I'm keeping the small circle on him. I'd say I could do it at least 50% of the time. I'm really not having to work too hard in doing it. It's definitely controllable. I can definitely get adequate performance. Is it satisfactory without improvement? Yes. Desired performance does require some compensation. It's really sitting at the bottom side of desired performance and minimal compensation. I'd say one reason it's minimal compensation is that it is hard for me to describe what kind of compensation I'm making. Everything seems pretty natural, it's just a fairly tight task trying to hold the pipper right on him most of the time. It's more of a problem in turns also than it is straight level. Straight level is very easy. I'd probably move it up a notch if the task was just straight and level but with the turns it's more difficult to keep the pipper on the guy. And trying to control my airspeed does distract for the tracking from time to time.

STEM 19 TEST 1
PILOT H
LONGITUDINAL CONFIGURATION 306
LATERAL CONFIGURATION 200
CHR 5

It definitely feels squirelly laterally. I think when I roll I get pure yaw almost. Pitch doesn't seem to be too bad. Is it controllable? Yes. Is adequate performance attainable? Yes. Is it satisfactory without improvement? No. I don't think I was quite getting desired performance. Adequate performance is actually extremely easy. I'm going to call it moderately objectionable deficiencies. The lateral control was fairly sensitive and was moving around a lot and that caused the difficulty in trying to keep it within the circle. The pitch seemed fairly decent.

STEM 19 TEST 1
PILOT H
LONGITUDINAL CONFIGURATION 306
LATERAL CONFIGURATION 200
CHR 4

It seems like I'm getting a little nose wandering laterally. A lot more than the previous configurations. I'm not really noticing it until he's turning. Then it's getting a little bit harder to keep him in there. I'm just getting a little bit of that lateral drift in there at times that I had to compensate for. Is it controllable? Yes. Is adequate performance attainable? Yes. Is it satisfactory without improvement? Not quite. I got desired performance. The compensation comes in the lateral axis. Most of the time I was able to track him and when it drifted off, it was either to the left or the right. I would call that minor but annoying deficiencies in the lateral axis. The pitch control seemed pretty tight.

STEM 19 TEST 1
PILOT G
LONGITUDINAL CONFIGURATION 307
LATERAL CONFIGURATION 200
CHR 3

I am not seeing that much difference in tracking capability from the previous one (Longitudinal configuration 307, lateral configuration 200). It seems like I am wandering laterally a little bit more, it may be a little more sensitive. It doesn't look like my performance is quite as good as far as tracking him. My airspeed definitely seems to be a lot more variable. I'm having a hard time determining if there's anything much to comment on these dynamics versus the previous set. My performance is a little worse. It does seem like there's a little more oscillation in pitch than I had previously. More lateral oscillations. It was definitely controllable. Adequate performance was attainable. Is it satisfactory without improvement? I'll say yes. Minimum pilot compensation required for desired performance. I don't have much to say about it. It seemed a little more bobbley in pitch but not very much. The tracking was about the same. The performance didn't seem quite as good but I didn't notice any particular pilot compensation being used. Whatever was there was probably minimal.

STEM 19 TEST 1
PILOT H
LONGITUDINAL CONFIGURATION 307
LATERAL CONFIGURATION 200
CHR 5

The pitch control seems different. It feels like there might be some delay there or some sluggishness in response to the pitch inputs. Is it controllable? Yes. Adequate performance is obtainable. Is it satisfactory without improvement? No. The roll still seems kind of twitchy and appears almost as pure yaw but also the pitch seems kind of sluggish. I was having more problems in pitch. If I could get on the target before I turned and just sit it there and basically perform an open loop task, I didn't really have any problems keeping it there. But as the turn started and I got a problem in both axes that made it difficult so I didn't get desired performance. This time I didn't like the pitch or the roll.

STEM 19 TEST 1
PILOT G
LONGITUDINAL CONFIGURATION 308
LATERAL CONFIGURATION 200
CHR 4

I am having a hard time maintaining the pitch attitude that I want. The tendency is to overpull. I tend to bobble off the top of the target. There is a lot up and down motion...It is a lot more pitch sensitive or something. Lighter forces required. The lateral is not that bad. I don't see his turns affecting me that much. I really bobble in pitch. We had discussed the range stuff and obviously when you get too far out of the range, the mils become meaningless as far as criteria. It is a lot more bobbley in pitch especially if I try to trim towards neutral. It seems to be more of a tendency pulling up than it is going down. It is

controllable. Adequate performance is attainable. The circle is pretty big. You might have to get some pretty bad dynamics to not be able to keep it within a 50 mil circle. Is it satisfactory without improvement? No. Adequate performance is no sweat. Desired performance is obtainable however there's a problem with the pitch being too sensitive. It's more bobbley. I see more wanderings especially in nose up direction. It seems I tend to bounce. I'll put it on the target, it'd bounce up, I would put it on the target, it would bounce up, put it on the target, bounce up. So something going on in the longitudinal axis here.

STEM 19 TEST 1
PILOT H
LONGITUDINAL CONFIGURATION 308
LATERAL CONFIGURATION 200
CHR 6

The pitch for this feels very sensitive. This time I definitely feel like I'm getting into a pitch PIO. The lateral feels okay. Just a pitch problem. Is it controllable? Yes. Is adequate performance attainable? Yes. Is it satisfactory without improvement? No. I didn't like the PIO on that one at all. I was able to get adequate performance but I wasn't able to get desired. To even to get close I really had to use what I would call extensive pilot compensation. And I felt like I was getting into a pitch PIO there. It wasn't responding the way it's supposed to. So I'll call that very objectionable. The lateral axis didn't seem to be a problem and if it was I didn't notice it.

STEM 19 TEST 1
PILOT G
LONGITUDINAL CONFIGURATION 306
LATERAL CONFIGURATION 201
CHR 4

This one seems pretty nice so far. A little pitch bobble. Very little lateral oscillation it seems like. The stick is very, very light. It is controllable. Adequate performance once again is not a problem. I don't think I found it quite so satisfactory though. It did seem like I was not able to track the target quite as well. Once again, adequate performance has never been a problem. Desired performance requires moderate pilot compensation. I'd say that it's probably a little better than moderate compensation but I wouldn't be able to describe what the compensation is. I didn't find any particular deficiencies that I could pull out laterally or pitchwise but it did seem to be more difficult to track.

STEM 19 TEST 1
PILOT H
LONGITUDINAL CONFIGURATION 306
LATERAL CONFIGURATION 201
CHR 3

That one felt pretty good. It felt pretty tight. Is it controllable? Yes. Is adequate performance attainable? Yes. Is it satisfactory without improvement? Yes. I was fairly comfortable with tracking it even through the turns. Minimal pilot compensation was required. The only compensation I was doing that time was a little more laterally. It seemed to be a

little more sensitive. It might be the pendulum effect we're looking at but other than that, I thought it was a pretty tight airplane. So, the mildly unpleasant deficiency was the lateral yaw type movement when I put in lateral inputs but the pitch control seemed to be quite nice. No tendency to PIO.

STEM 19 TEST 1
PILOT G
LONGITUDINAL CONFIGURATION 306
LATERAL CONFIGURATION 204
CHR 3

It seems pretty easy to track straight and level. A little bit of lateral oscillation in the turn. The tracking once again is pretty easy. It is fairly light though in pitch. I can nail it right on. It's real stable once you get the pipper on. It is definitely controllable. Adequate performance is easily obtainable. And it is satisfactory without improvement. It is not perfect. You have to be a little careful in roll. The pitch may be a little sensitive. There wasn't much compensation required. That may be due partly to the wide tolerance that we have given ourselves here.

STEM 19 TEST 1
PILOT H
LONGITUDINAL CONFIGURATION 306
LATERAL CONFIGURATION 204
CHR 5

This one feels a little bit sensitive in pitch. Is it controllable? Yes. Is adequate performance attainable? Yes. Is it satisfactory without improvement? No. The nose didn't really want to stay where I put it. Once I got it there it seemed to drift off. It didn't really want to stay there. I don't think I got desired performance. Considerable compensation was required in both axes just to keep that pipper on the target. I will call that moderately objectionable. Initially it seemed real sensitive in pitch and then it just seems to wander off the target in both axes as I'm tracking it. I was always having to make these real abrupt inputs to get it back on.

STEM 19 TEST 1
PILOT H
LONGITUDINAL CONFIGURATION 306
LATERAL CONFIGURATION 204
CHR 4
(Note: Changed reticle depression to 70 mils)

It seems easier to track him in a turn when it's depressed like this. It doesn't seem as hard laterally. Is it controllable? Yes. Is adequate performance attainable? Yes. Is it satisfactory without improvement? No. I was getting desired performance most of the time. It required moderate pilot compensation because when I would get him on the target it seemed to be wandering off in pitch and I was having to make too many little corrections to keep it on the target. It was not too bad at times but making corrections was real tough so that's a minor but annoying deficiencies. I mainly noticed it in pitch.

## Summary of Design Parameters Tested for STEM 19 TEST 2

Test variables:
CAP: Control Anticipation Parameter, also results in a variation in short period frequency
- 0.16
- 0.28

ZSP: Short period damping held constant at 0.8

TR: Roll mode time constant
- 0.5 sec
- 1.0 sec
- 1.6 sec

PMAX: Maximum stability axis roll rate held constant at 40 deg/sec

### Test Matrix

| Lon Config | Lat Config | CAP | TR |
|---|---|---|---|
| 505 | 403 | 0.16 | 1.0 |
| 504 | 402 | 0.28 | 0.5 |
| 504 | 402* | 0.28 | 1.6 |

STEM 19 TEST 2 (Transport Aircraft Testing)
PILOT I
LONGITUDINAL CONFIGURATION 505
LATERAL CONFIGURATION 403
CHR 5
PIO -

The pitch control on the recapture there was pretty nice. It's controllable. Adequate performance is attainable with a tolerable pilot workload. I don't think it's satisfactory without improvement. It looks like to me all that I'm getting is the adequate performance. The pipper is coming off the aim point in the start of the turns because of the pendulum effect. Although in just doing pipper repositions from the wing tip to the wing tip it seems to have pretty good lateral flying qualities and the pitch flying qualities were fine. The rate of response on the recorrections was fine. That's why I'm a little bit confused on the problem I'm having there with the pipper coming off. I was able to make a fairly quick movement from wing tip to wing tip and stop the pipper pretty much where I wanted it.

STEM 19 TEST 2 (Transport Aircraft Testing)
PILOT I
LONGITUDINAL CONFIGURATION 504
LATERAL CONFIGURATION 402
CHR 5
PIO -

I am stair stepping the pitch corrections a little bit. He basically banks but does not change his position in the pipper which causes me to lag the turn pretty good. And when I seen him come out of the bank I want to come out of the bank but that causes a pipper displacement for me. I basically didn't see any change between this and the last (Longitudinal configuration 504, lateral configuration 402). There certainly isn't enough pitch gain in this to bring out anything. It does require harmony in the maneuver that I think some of the other maneuvers don't.

STEM 19 TEST 2 (Transport Aircraft Testing)
PILOT I
LONGITUDINAL CONFIGURATION 504
LATERAL CONFIGURATION 402* (Tr=1.6sec)
CHR 7
PIO -

I'm seeing a sloppiness in roll on this one that I had not seen before. On this one I am seeing a pretty good degradation in the flying qualities of the airplane. Mainly during the task I saw the roll problem. Right now I'm dropping the nose and then trying to pull up to the burner cans, stop it, and I get into a little bit of a PIO there when I am trying to really aggressively track the burner cans. I don't think I'm getting desired or adequate performance. Control is not in question but I just can't get the adequate performance. Any pipper displacement resulted in lateral problems. Just reacquiring the performance criteria caused some lateral PIO.

**Data Contents for STEM 20: Offset Approach to Landing**

- Summary of Design Parameter Variations Tested
- Numerical Summary of Statistical Analysis
- Bar Graphs of Measures of Merit
- Design Parameter Correlations, Pilot Variability, and Overall Correlations
- Pilot Comments

## Summary of Design Parameters Tested for STEM 20

Test variables:

PMAX: Indicates the maximum stability axis roll rate available from a full stick input. Implemented as a constant, not a function of AOA. Also directly affects the lateral stick sensitivity:

(-) 50°/sec

(+) 80°/sec

TR: Indicates the stability axis roll mode time constant. Implemented as a constant, not a function of AOA:

(-) 1.0 sec

(+) 0.6 sec

CAP: Indicates a variation in $\omega_{sp}$. $\omega_{sp}$ scheduled linearly with knots equivalent airspeed (KEAS) with the following value at 100 KEAS:

(-) 1.0 rad/sec

(+) 1.5 rad/sec

ZSP: A constant $\zeta_{sp}$ was maintanined:

(-) 0.5

(+) 0.8

TAUENG: Engine time constant. This controls the rate of thrust response to throttle input:

(-) 1.0 sec, slow

(+) 0.5 sec, fast

TIMDEL: Indicates the amount of pure time delay added in the simulation. This is in addition to the inherent computational and visual scene update delays

(-) 0, No additional time delay beyond the ≈100 msec due to the simulation setup.

(+) 83.5 msec, Results in approximately 183.5 msec of time delay (Level 2, nearing Level 3).

LALPHA: Indicates a variation on lift curve slope (however, Clmax was held constant) and pitch rate lead term.:

(-) 0.6 (per rad), Nominal, corresponds to $T_{\theta 2}$ = 1.67 sec

(+) 0.78 (per rad), 1.3*nominal, corresponds to $T_{\theta 2}$ = 1.28 sec

### Test Matrix (Pilots A,F)

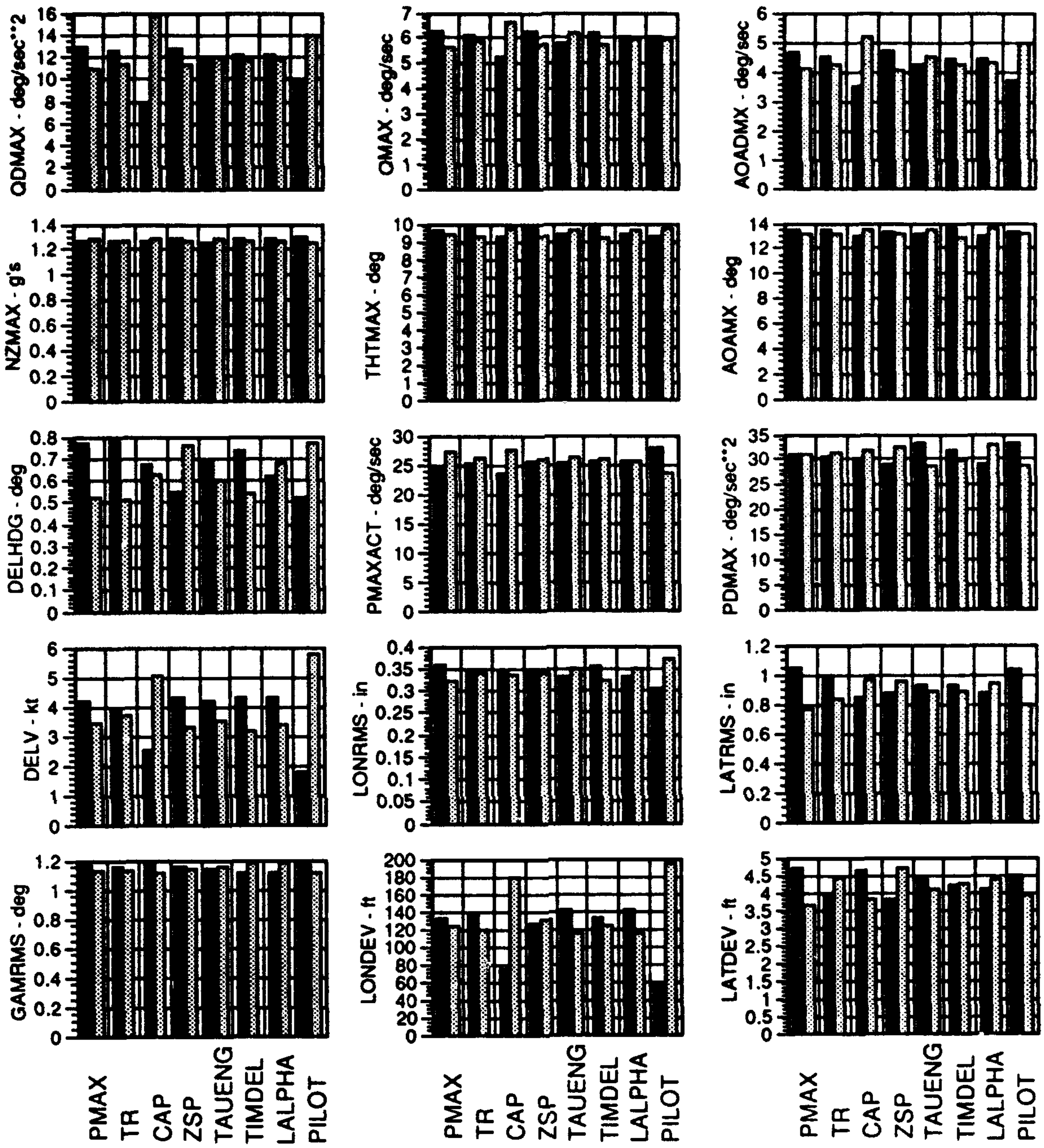
| Lon | Lat | PMAX | TR | CAP | ZSP | TAUENG | TIMDEL | LALPHA |
|---|---|---|---|---|---|---|---|---|
| 180 | 24 | 50 (-) | 1.0 (-) | 1.0 (-) | 0.8 (+) | 0.5 (+) | 0 (+) | 0.78 (-) |
| 181 | 25 | 80 (+) | 1.0 (-) | 1.0 (-) | 0.5 (-) | 1.0 (-) | 0 (+) | 0.6 (+) |
| 182 | 26 | 50 (-) | 0.6 (+) | 1.0 (-) | 0.5 (-) | 0.5 (+) | 83.5 (-) | 0.6 (+) |
| 183 | 27 | 80 (+) | 0.6 (+) | 1.0 (-) | 0.8 (+) | 1.0 (-) | 83.5 (-) | 0.78 (-) |
| 184 | 28 | 50 (-) | 1.0 (-) | 1.5 (+) | 0.8 (+) | 1.0 (-) | 83.5 (-) | 0.6 (+) |
| 185 | 29 | 80 (+) | 1.0 (-) | 1.5 (+) | 0.5 (-) | 0.5 (+) | 83.5 (-) | 0.78 (-) |
| 186 | 30 | 50 (-) | 0.6 (+) | 1.5 (+) | 0.5 (-) | 1.0 (-) | 0 (+) | 0.78 (-) |
| 187 | 31 | 80 (+) | 0.6 (+) | 1.5 (+) | 0.8 (+) | 0.5 (+) | 0 (+) | 0.6 (+) |

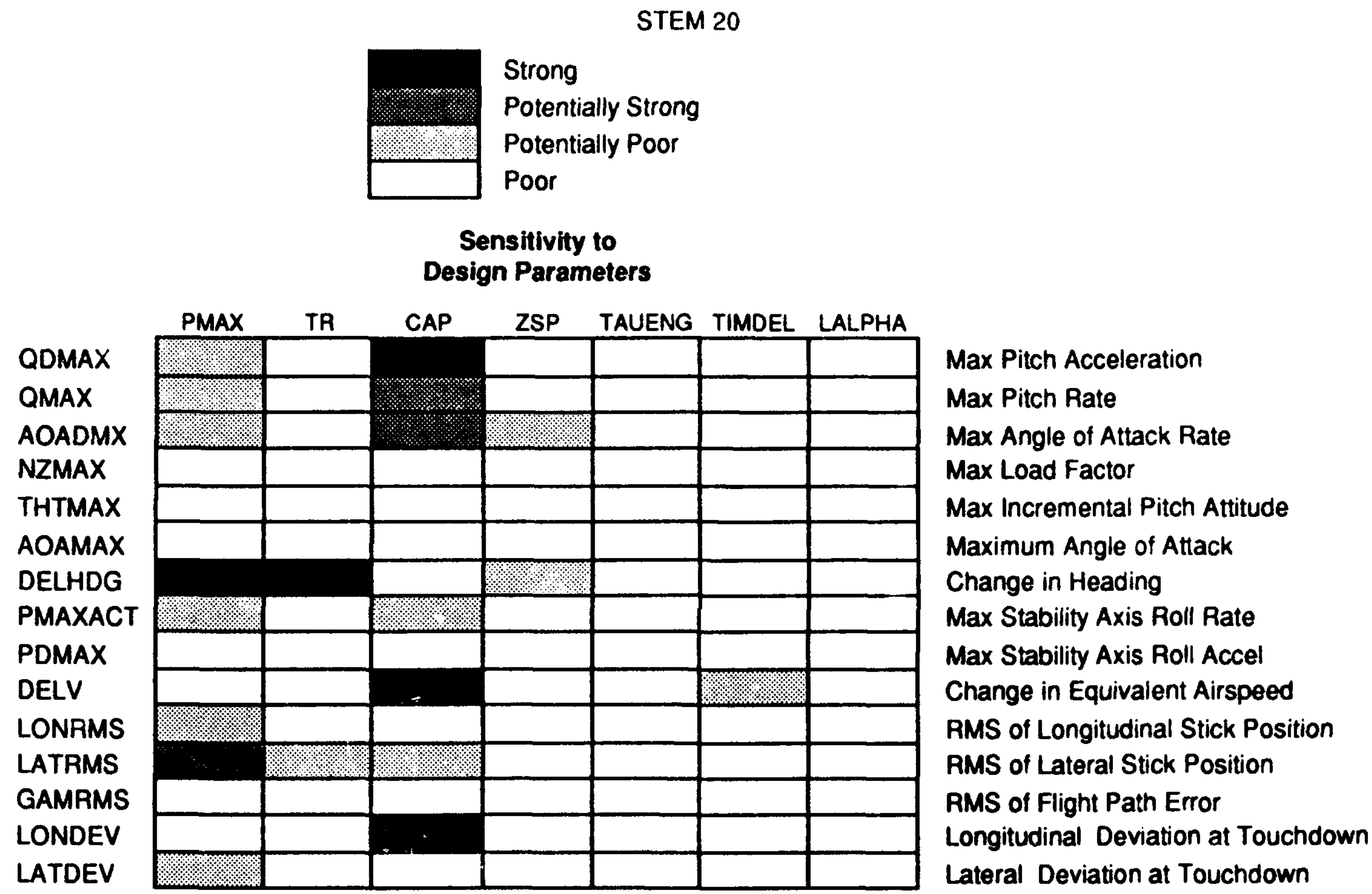
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | QDMAX | 0.9999 | PMAX | 0.941 | 12.906 | 10.991 | 0 | 0 | -0.161 | 0.47 | 3 | 3 | 4 |
| | | | TR | 0.809 | 12.603 | 11.362 | 0 | 0 | -0.104 | 0.30 | 4 | 3 | 4 |
| | | | CAP | 1.000 | 7.8516 | 15.828 | 0 | 0 | 0.760 | 2.20 | 1 | 1 | 1 |
| | | | ZSP | 0.858 | 12.68 | 11.234 | 0 | 0 | -0.121 | 0.35 | 4 | 3 | 4 |
| | | | TAUENG | 0.223 | 11.94 | 12.025 | 0 | 0 | 0.007 | 0.02 | 4 | 3 | 4 |
| | | | TIMDEL | 0.401 | 12.21 | 11.701 | 0 | 0 | -0.043 | 0.12 | 4 | 3 | 4 |
| | | | LALPHA | 0.231 | 12.18 | 11.785 | 0 | 0 | -0.033 | 0.10 | 4 | 3 | 4 |
| | | | PLT | 0.998 | 9.9133 | 13.909 | 0 | 0 | 0.345 | | | | |
| 8 | QMAX | 0.9817 | PMAX | 0.943 | 6.3054 | 5.6607 | 0 | 0 | -0.108 | 9.77 | 3 | 1 | 3 |
| | | | TR | 0.526 | 6.1017 | 5.8874 | 0 | 0 | -0.036 | 3.23 | 4 | 1 | 4 |
| | | | CAP | 1.000 | 5.2681 | 6.6709 | 0 | 0 | 0.238 | 21.55 | 2 | 1 | 2 |
| | | | ZSP | 0.921 | 6.2776 | 5.6905 | 0 | 0 | -0.098 | 8.89 | 4 | 1 | 4 |
| | | | TAUENG | 0.742 | 5.812 | 6.1771 | 0 | 0 | 0.061 | 5.51 | 4 | 1 | 4 |
| | | | TIMDEL | 0.803 | 6.191 | 5.7509 | 0 | 0 | -0.074 | 6.67 | 4 | 1 | 4 |
| | | | LALPHA | 0.211 | 6.0302 | 5.9589 | 0 | 0 | -0.012 | 1.07 | 4 | 2 | 4 |
| | | | PLT | 0.497 | 6.0289 | 5.9626 | 0 | 0 | -0.011 | | | | |
| 11 | AOADMX | 0.9999 | PMAX | 0.964 | 4.644 | 4.0768 | 0 | 0 | -0.131 | 0.45 | 3 | 3 | 4 |
| | | | TR | 0.762 | 4.5171 | 4.224 | 0 | 0 | -0.067 | 0.23 | 4 | 3 | 4 |
| | | | CAP | 1.000 | 3.5292 | 5.1539 | 0 | 0 | 0.388 | 1.34 | 2 | 2 | 3 |
| | | | ZSP | 0.982 | 4.6775 | 4.0409 | 0 | 0 | -0.147 | 0.51 | 3 | 3 | 4 |
| | | | TAUENG | 0.688 | 4.2419 | 4.4992 | 0 | 0 | 0.059 | 0.20 | 4 | 3 | 4 |
| | | | TIMDEL | 0.602 | 4.473 | 4.2435 | 0 | 0 | -0.053 | 0.18 | 4 | 3 | 4 |
| | | | LALPHA | 0.419 | 4.4474 | 4.2937 | 0 | 0 | -0.035 | 0.12 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 3.733 | 4.9642 | 0 | 0 | 0.289 | | | | |
| 14 | NZMAX | 0.9848 | PMAX | 0.483 | 1.271 | 1.28 | 0 | 0 | 0.007 | 0.16 | 4 | 3 | 4 |
| | | | TR | 0.089 | 1.2747 | 1.2759 | 0 | 0 | 0.001 | 0.02 | 4 | 3 | 4 |
| | | | CAP | 0.316 | 1.2725 | 1.2779 | 0 | 0 | 0.004 | 0.10 | 4 | 3 | 4 |
| | | | ZSP | 0.876 | 1.2857 | 1.2642 | 0 | 0 | -0.017 | 0.38 | 4 | 3 | 4 |
| | | | TAUENG | 0.928 | 1.2616 | 1.2891 | 0 | 0 | 0.022 | 0.48 | 4 | 3 | 4 |
| | | | TIMDEL | 0.710 | 1.2823 | 1.2668 | 0 | 0 | -0.012 | 0.27 | 4 | 3 | 4 |
| | | | LALPHA | 0.906 | 1.2875 | 1.2631 | 0 | 0 | -0.019 | 0.43 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 1.3048 | 1.2479 | 0 | 0 | -0.045 | | | | |
| 18 | THTMAX | 0.9628 | PMAX | 0.710 | 9.6392 | 9.409 | 0 | 0 | -0.024 | 0.44 | 4 | 3 | 4 |
| | | | TR | 0.926 | 9.721 | 9.3354 | 0 | 0 | -0.040 | 0.73 | 4 | 3 | 4 |
| | | | CAP | 0.940 | 9.2926 | 9.7476 | 0 | 0 | 0.048 | 0.87 | 4 | 3 | 4 |
| | | | ZSP | 0.908 | 9.7007 | 9.343 | 0 | 0 | -0.038 | 0.68 | 4 | 3 | 4 |
| | | | TAUENG | 0.627 | 9.424 | 9.6324 | 0 | 0 | 0.022 | 0.40 | 4 | 3 | 4 |
| | | | TIMDEL | 0.979 | 9.7664 | 9.2328 | 0 | 0 | -0.056 | 1.02 | 4 | 2 | 4 |
| | | | LALPHA | 0.688 | 9.4104 | 9.6461 | 0 | 0 | 0.025 | 0.45 | 4 | 3 | 4 |
| | | | PLT | 0.963 | 9.2568 | 9.7809 | 0 | 0 | 0.055 | | | | |
| 20 | AOAMX | 0.9999 | PMAX | 0.888 | 13.41 | 13.13 | 0 | 0 | -0.021 | 2.52 | 4 | 1 | 4 |
| | | | TR | 0.922 | 13.426 | 13.124 | 0 | 0 | -0.023 | 2.71 | 4 | 1 | 4 |
| | | | CAP | 0.962 | 13.067 | 13.468 | 0 | 0 | 0.030 | 3.61 | 4 | 1 | 4 |
| | | | ZSP | 0.768 | 13.37 | 13.172 | 0 | 0 | -0.015 | 1.78 | 4 | 2 | 4 |
| | | | TAUENG | 0.842 | 13.152 | 13.397 | 0 | 0 | 0.018 | 2.20 | 4 | 1 | 4 |
| | | | TIMDEL | 1.000 | 13.634 | 12.829 | 0 | 0 | -0.061 | 7.27 | 4 | 1 | 4 |
| | | | LALPHA | 0.998 | 12.974 | 13.576 | 0 | 0 | 0.045 | 5.41 | 4 | 1 | 4 |
| | | | PLT | 0.605 | 13.332 | 13.221 | 0 | 0 | -0.008 | | | | |
| 28 | DELHDG | 0.6198 | PMAX | 0.903 | 0.7674 | 0.5192 | 0 | 0 | -0.401 | 1.01 | 1 | 2 | 2 |
| | | | TR | 0.934 | 0.7811 | 0.5144 | 0 | 0 | -0.430 | 1.08 | 1 | 2 | 2 |
| | | | CAP | 0.410 | 0.6734 | 0.6238 | 0 | 0 | -0.077 | 0.19 | 4 | 3 | 4 |
| | | | ZSP | 0.829 | 0.5446 | 0.7585 | 0 | 0 | 0.337 | 0.85 | 3 | 3 | 4 |
| | | | TAUENG | 0.336 | 0.6936 | 0.6019 | 0 | 0 | -0.142 | 0.36 | 4 | 3 | 4 |
| | | | TIMDEL | 0.781 | 0.733 | 0.5421 | 0 | 0 | -0.306 | 0.77 | 4 | 3 | 4 |
| | | | LALPHA | 0.111 | 0.6157 | 0.6798 | 0 | 0 | 0.099 | 0.25 | 4 | 3 | 4 |
| | | | PLT | 0.919 | 0.5204 | 0.7663 | 0 | 0 | 0.397 | | | | |

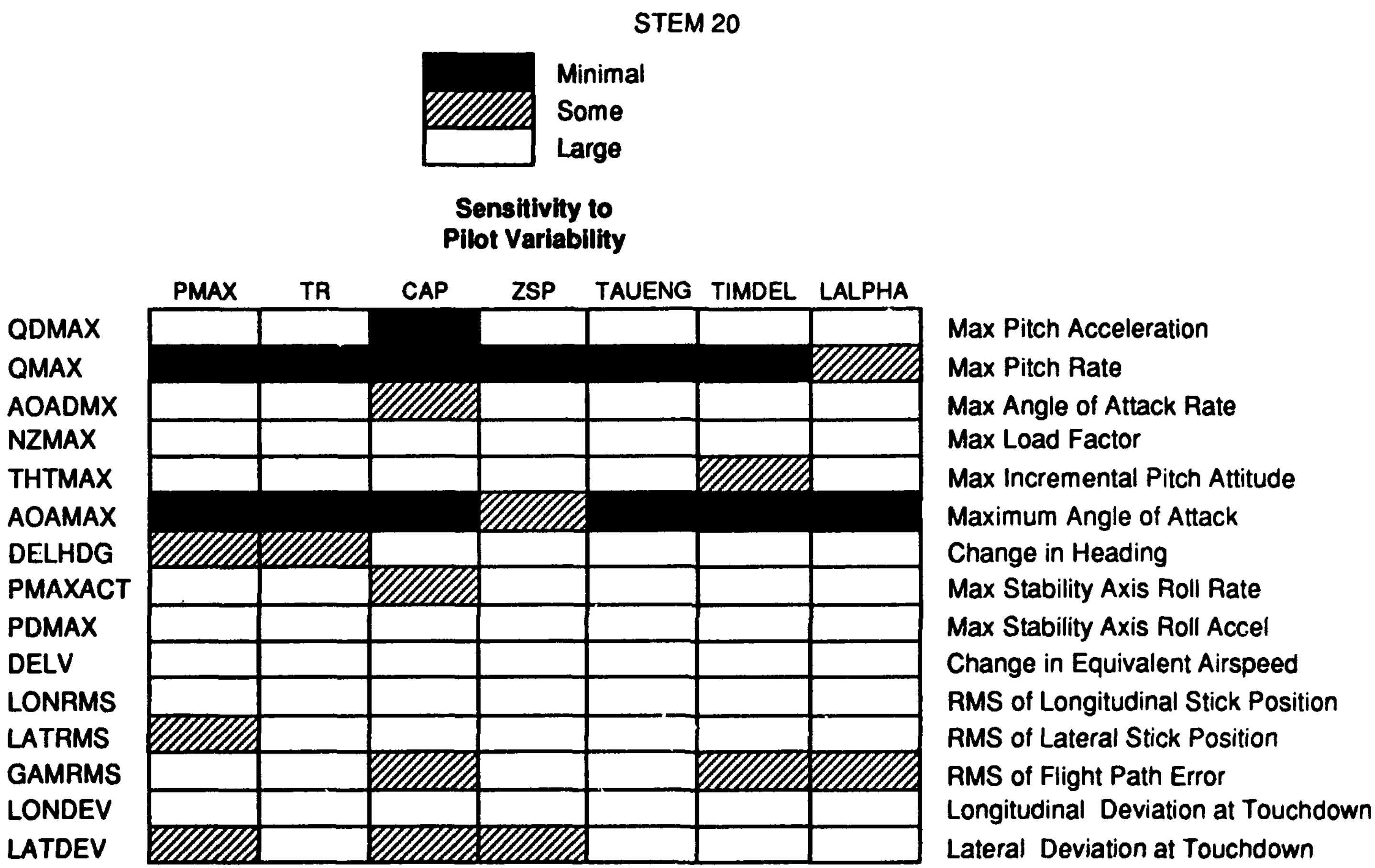
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | PMAXACT | 0.9991 | PMAX | 0.994 | 24.049 | 27.318 | 0 | 0 | 0.128 | 0.81 | 3 | 3 | 4 |
| | | | TR | 0.633 | 25.17 | 26.08 | 0 | 0 | 0.036 | 0.22 | 4 | 3 | 4 |
| | | | CAP | 1.000 | 23.437 | 27.663 | 0 | 0 | 0.167 | 1.05 | 3 | 2 | 4 |
| | | | ZSP | 0.157 | 25.542 | 25.714 | 0 | 0 | 0.007 | 0.04 | 4 | 3 | 4 |
| | | | TAUENG | 0.671 | 25.104 | 26.146 | 0 | 0 | 0.041 | 0.26 | 4 | 3 | 4 |
| | | | TIMDEL | 0.099 | 25.554 | 25.713 | 0 | 0 | 0.006 | 0.04 | 4 | 3 | 4 |
| | | | LALPHA | 0.371 | 25.605 | 25.646 | 0 | 0 | 0.002 | 0.01 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 27.715 | 23.679 | 0 | 0 | -0.158 | | | | |
| 32 | PDMAX | 0.1096 | PMAX | 0.029 | 30.951 | 30.821 | 0 | 0 | -0.004 | 0.03 | 4 | 3 | 4 |
| | | | TR | 0.183 | 30.473 | 31.303 | 0 | 0 | 0.027 | 0.17 | 4 | 3 | 4 |
| | | | CAP | 0.370 | 30.048 | 31.67 | 0 | 0 | 0.053 | 0.33 | 4 | 3 | 4 |
| | | | ZSP | 0.673 | 29.207 | 32.693 | 0 | 0 | 0.113 | 0.71 | 4 | 3 | 4 |
| | | | TAUENG | 0.762 | 33.22 | 28.556 | 0 | 0 | -0.152 | 0.95 | 4 | 3 | 4 |
| | | | TIMDEL | 0.491 | 31.864 | 29.679 | 0 | 0 | -0.071 | 0.44 | 4 | 3 | 4 |
| | | | LALPHA | 0.737 | 28.827 | 32.95 | 0 | 0 | 0.134 | 0.84 | 4 | 3 | 4 |
| | | | PLT | 0.790 | 33.437 | 28.515 | 0 | 0 | -0.160 | | | | |
| 39 | DELV | 0.9983 | PMAX | 0.605 | 4.1781 | 3.4437 | 0 | 0 | -0.195 | 0.13 | 4 | 3 | 4 |
| | | | TR | 0.229 | 3.9361 | 3.712 | 0 | 0 | -0.059 | 0.04 | 4 | 3 | 4 |
| | | | CAP | 0.995 | 2.5155 | 5.0423 | 0 | 0 | 0.753 | 0.51 | 1 | 3 | 3 |
| | | | ZSP | 0.744 | 4.2973 | 3.3157 | 0 | 0 | -0.262 | 0.18 | 4 | 3 | 4 |
| | | | TAUENG | 0.557 | 4.1578 | 3.4903 | 0 | 0 | -0.176 | 0.12 | 4 | 3 | 4 |
| | | | TIMDEL | 0.828 | 4.3392 | 3.1852 | 0 | 0 | -0.314 | 0.21 | 3 | 3 | 4 |
| | | | LALPHA | 0.718 | 4.2906 | 3.3575 | 0 | 0 | -0.248 | 0.17 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 1.7546 | 5.7507 | 0 | 0 | 1.486 | | | | |
| 42 | LONRMS | 0.9974 | PMAX | 0.979 | 0.3582 | 0.3215 | 0 | 0 | -0.108 | 0.53 | 3 | 3 | 4 |
| | | | TR | 0.242 | 0.3422 | 0.3388 | 0 | 0 | -0.010 | 0.05 | 4 | 3 | 4 |
| | | | CAP | 0.274 | 0.343 | 0.3381 | 0 | 0 | -0.014 | 0.07 | 4 | 3 | 4 |
| | | | ZSP | 0.002 | 0.3404 | 0.3406 | 0 | 0 | 0.001 | 0.00 | 4 | 3 | 4 |
| | | | TAUENG | 0.783 | 0.3316 | 0.3494 | 0 | 0 | 0.052 | 0.26 | 4 | 3 | 4 |
| | | | TIMDEL | 0.961 | 0.3554 | 0.3221 | 0 | 0 | -0.099 | 0.48 | 4 | 3 | 4 |
| | | | LALPHA | 0.521 | 0.3324 | 0.3486 | 0 | 0 | 0.048 | 0.23 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 0.305 | 0.3735 | 0 | 0 | 0.204 | | | | |
| 43 | LATRMS | 0.9999 | PMAX | 1.000 | 1.0466 | 0.7672 | 0 | 0 | -0.316 | 1.19 | 2 | 2 | 3 |
| | | | TR | 1.000 | 0.994 | 0.8298 | 0 | 0 | -0.182 | 0.68 | 3 | 3 | 4 |
| | | | CAP | 0.978 | 0.8481 | 0.9713 | 0 | 0 | 0.136 | 0.51 | 3 | 3 | 4 |
| | | | ZSP | 0.884 | 0.8746 | 0.9519 | 0 | 0 | 0.085 | 0.32 | 4 | 3 | 4 |
| | | | TAUENG | 0.270 | 0.9303 | 0.8935 | 0 | 0 | -0.040 | 0.15 | 4 | 3 | 4 |
| | | | TIMDEL | 0.691 | 0.9341 | 0.8843 | 0 | 0 | -0.055 | 0.21 | 4 | 3 | 4 |
| | | | LALPHA | 0.577 | 0.8787 | 0.945 | 0 | 0 | 0.073 | 0.27 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 1.0358 | 0.7965 | 0 | 0 | -0.266 | | | | |
| 44 | GAMRMS | 0.9959 | PMAX | 0.743 | 1.167 | 1.1258 | 0 | 0 | -0.036 | 0.78 | 4 | 3 | 4 |
| | | | TR | 0.538 | 1.1597 | 1.1346 | 0 | 0 | -0.022 | 0.47 | 4 | 3 | 4 |
| | | | CAP | 0.965 | 1.186 | 1.111 | 0 | 0 | -0.065 | 1.42 | 4 | 2 | 4 |
| | | | ZSP | 0.317 | 1.1537 | 1.1401 | 0 | 0 | -0.012 | 0.26 | 4 | 3 | 4 |
| | | | TAUENG | 0.247 | 1.1401 | 1.1542 | 0 | 0 | 0.012 | 0.27 | 4 | 3 | 4 |
| | | | TIMDEL | 0.901 | 1.1208 | 1.1799 | 0 | 0 | 0.051 | 1.11 | 4 | 2 | 4 |
| | | | LALPHA | 0.881 | 1.1165 | 1.1779 | 0 | 0 | 0.054 | 1.16 | 4 | 2 | 4 |
| | | | PLT | 0.820 | 1.1746 | 1.1216 | 0 | 0 | -0.046 | | | | |
| 46 | LONDEV | 0.9999 | PMAX | 0.265 | 131.73 | 124.29 | 0 | 0 | -0.058 | 0.04 | 4 | 3 | 4 |
| | | | TR | 0.596 | 137.2 | 119.08 | 0 | 0 | -0.142 | 0.09 | 4 | 3 | 4 |
| | | | CAP | 1.000 | 73.902 | 178.64 | 0 | 0 | 1.002 | 0.63 | 1 | 3 | 3 |
| | | | ZSP | 0.112 | 126.46 | 129.95 | 0 | 0 | 0.027 | 0.02 | 4 | 3 | 4 |
| | | | TAUENG | 0.679 | 141.17 | 115.11 | 0 | 0 | -0.206 | 0.13 | 4 | 3 | 4 |
| | | | TIMDEL | 0.326 | 131.86 | 123.53 | 0 | 0 | -0.065 | 0.04 | 4 | 3 | 4 |
| | | | LALPHA | 0.719 | 141.25 | 115.03 | 0 | 0 | -0.207 | 0.13 | 4 | 3 | 4 |
| | | | PLT | 1.000 | 56.245 | 195.08 | 0 | 0 | 1.590 | | | | |

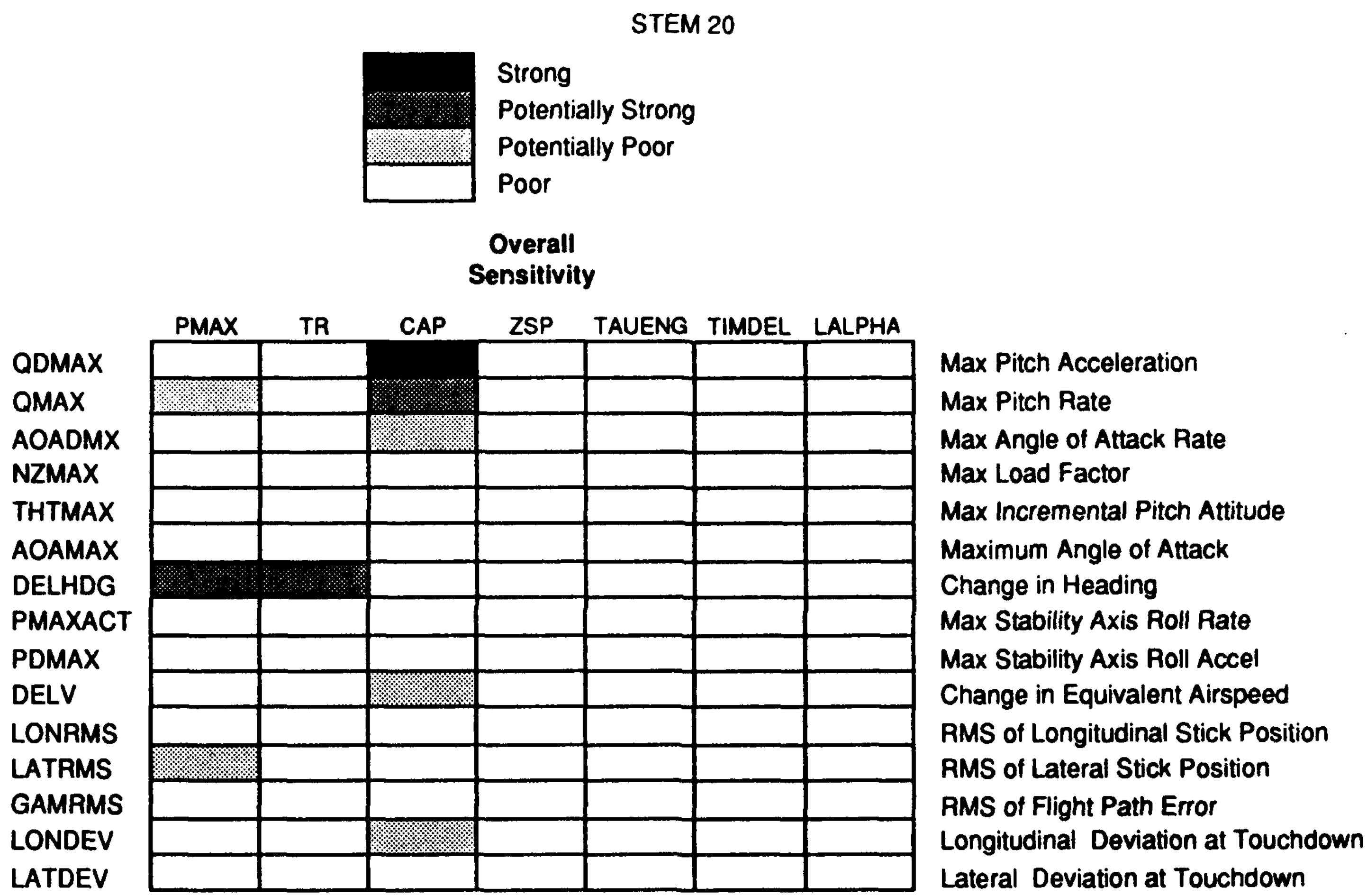
| | MOM | Model Sig | Var Name | Sig | Mean 1 | Mean 2 | Mean 3 | Mean 4 | %Change | Ratio | Design | Pilot | Overall |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 47 | LATDEV | 0.8464 | PMAX | 0.825 | 4.7225 | 3.6707 | 0 | 0 | -0.255 | 1.91 | 3 | 2 | 4 |
| | | | TR | 0.404 | 3.9929 | 4.4378 | 0 | 0 | 0.106 | 0.79 | 4 | 3 | 4 |
| | | | CAP | 0.682 | 4.6356 | 3.8241 | 0 | 0 | -0.194 | 1.45 | 4 | 2 | 4 |
| | | | ZSP | 0.754 | 3.7882 | 4.6741 | 0 | 0 | 0.212 | 1.59 | 4 | 2 | 4 |
| | | | TAUENG | 0.158 | 4.3442 | 4.0865 | 0 | 0 | -0.061 | 0.46 | 4 | 3 | 4 |
| | | | TIMDEL | 0.077 | 4.1749 | 4.2656 | 0 | 0 | 0.021 | 0.16 | 4 | 3 | 4 |
| | | | LALPHA | 0.101 | 4.0835 | 4.3472 | 0 | 0 | 0.063 | 0.47 | 4 | 3 | 4 |
| | | | PLT | 0.419 | 4.5054 | 3.9453 | 0 | 0 | -0.133 | | | | |

STEM 20


QDMAX - deg/sec**2
QMAX - deg/sec
AOADMX - deg/sec
NZMAX - g's
THTMAX - deg
AOAMX - deg
DELHDG - deg
PMAXACT - deg/sec
PDMAX - deg/sec**2
DELV - kt
LONRMS - in
LATRMS - in
GAMRMS - deg
LONDEV - ft
LATDEV - ft
PMAX
TR
CAP
ZSP
TAUENG
TIMDEL
LALPHA
PILOT


STEM 20
Strong
Potentially Strong
Potentially Poor
Poor
Sensitivity to Design Parameters
PMAX
TR
CAP
ZSP
TAUENG
TIMDEL
LALPHA
QDMAX
QMAX
AOADMX
NZMAX
THTMAX
AOAMAX
DELHDG
PMAXACT
PDMAX
DELV
LONRMS
LATRMS
GAMRMS
LONDEV
LATDEV
Max Pitch Acceleration
Max Pitch Rate
Max Angle of Attack Rate
Max Load Factor
Max Incremental Pitch Attitude
Maximum Angle of Attack
Change in Heading
Max Stability Axis Roll Rate
Max Stability Axis Roll Accel
Change in Equivalent Airspeed
RMS of Longitudinal Stick Position
RMS of Lateral Stick Position
RMS of Flight Path Error
Longitudinal Deviation at Touchdown
Lateral Deviation at Touchdown


STEM 20
Minimal
Some
Large
Sensitivity to
Pilot Variability
PMAX
TR
CAP
ZSP
TAUENG
TIMDEL
LALPHA
QDMAX
QMAX
AOADMX
NZMAX
THTMAX
AOAMAX
DELHDG
PMAXACT
PDMAX
DELV
LONRMS
LATRMS
GAMRMS
LONDEV
LATDEV
Max Pitch Acceleration
Max Pitch Rate
Max Angle of Attack Rate
Max Load Factor
Max Incremental Pitch Attitude
Maximum Angle of Attack
Change in Heading
Max Stability Axis Roll Rate
Max Stability Axis Roll Accel
Change in Equivalent Airspeed
RMS of Longitudinal Stick Position
RMS of Lateral Stick Position
RMS of Flight Path Error
Longitudinal Deviation at Touchdown
Lateral Deviation at Touchdown



STEM 20
Strong
Potentially Strong
Potentially Poor
Poor
Overall Sensitivity
PMAX
TR
CAP
ZSP
TAUENG
TIMDEL
LALPHA
QDMAX
QMAX
AOADMX
NZMAX
THTMAX
AOAMAX
DELHDG
PMAXACT
PDMAX
DELV
LONRMS
LATRMS
GAMRMS
LONDEV
LATDEV
Max Pitch Acceleration
Max Pitch Rate
Max Angle of Attack Rate
Max Load Factor
Max Incremental Pitch Attitude
Maximum Angle of Attack
Change in Heading
Max Stability Axis Roll Rate
Max Stability Axis Roll Accel
Change in Equivalent Airspeed
RMS of Longitudinal Stick Position
RMS of Lateral Stick Position
RMS of Flight Path Error
Longitudinal Deviation at Touchdown
Lateral Deviation at Touchdown

STEM 20
PILOT A
LONGITUDINAL CONFIGURATION 180
LATERAL CONFIGURATION 24

It's a pretty sluggish airplane. A little slow. It's difficult settling down the right power. It take a pretty high workload. The method I'm using for these things is a hard immediate correction slightly nose high to get on to center line. I'm trying to roll out on center line and then giving my self a few seconds to set up. What that means is I often end up with some left/right error, so I'm slightly off center line or slightly off heading, but not too badly. And then I'm trying to hit a 3 1/2 degree glide slope for the landing at a 135 knots. Sometimes I have to make a bit of a stab at the airspeed with last minute power change to get the airspeed correct, but normally I'm pretty close. And then trying to get touchdown at the right longitudinal part of the runway. Workload is pretty high. It is pretty demanding to try and do that from here. It's hard work, but's it's doable with this configuration. The airplane is sluggish, so it's hard to make the fine corrections, especially when you get time compressed. And especially laterally it's very sluggish.

STEM 20
PILOT F
LONGITUDINAL CONFIGURATION 180
LATERAL CONFIGURATION 24

The power response on this particular airplane is really really poor. It seems worse than the other ones. I think the less I mess with the power the better off I'm going to be. Again the roll and pitch capabilities of the aircraft are adequate. This configuration seems a little sloppier than the other ones. The power seems a lot more out of sink in this particular configuration than the other ones.

STEM 20
PILOT A
LONGITUDINAL CONFIGURATION 181
LATERAL CONFIGURATION 25

I'm trying to put it in-between the marks every time, but sometimes I just can't do it. I got a little bit fast and I was slightly off heading. I hustled it, got it in there, and touched down where I wanted to, but I had the power back up and did a light touch and go. I hate not having an E bracket. The airplane behaves all right. It's a little bit sluggish laterally. Longitudinally it seems all right. I'm making it on the runway every time left/right. I never missed that way. If I'm missing I'm off heading when I touch down slightly or I'm missing it longitudinally because I don't get things settled out or my airspeed is a little bit high, but it's doable. With a tolerable work load I seem to be able to get it down between the numbers a pretty good percentage of the time.

STEM 20
PILOT F
LONGITUDINAL CONFIGURATION 181
LATERAL CONFIGURATION 25

Sloppy in pitch. In this airplane if you go to 125 knots, you start a horrendous sink rate and it takes a lot of power to get out of it and then you're into a PIO. I'm fighting the power more than anything in this airplane. The roll and pitch are plenty adequate to get me over here. I'm not fighting any of that. I'm chasing the airspeed all over the place. Maybe the pitch control and the roll is causing some of that, but I can't tell. Mostly I'm having trouble with power. It seems like the power response is out of sink with the throttle. It may just be me, but it just doesn't feel right. So far, none of these configurations have any roll and pitch limitations to prevent me from getting over the runway. The problem is having the proper airspeed to keep from crashing because I'm slow or going long because I'm hot.

STEM 20
PILOT A
LONGITUDINAL CONFIGURATION 182
LATERAL CONFIGURATION 26

This is not a bad flying airplane. It gives me a lot of slop. I can mess it up a little and still make it. I can be off nominal and still recover. I seem to have extra time with this configuration because I'm not working too hard just to damp out the airframe characteristics. This is a pretty nice balance in this airplane. It gives me the confidence to do some pretty cowboyish things with the airplane. I'm making some big corrections and I still have pretty good response. I get a little bit off airspeed and it's easy to correct the airspeed, so it's good longitudinally. I was basically lined up every time. I didn't have much trouble lining up. Pretty reasonable response time laterally and longitudinally and it didn't take me very long to get three landings I was happy with.

STEM 20
PILOT F
LONGITUDINAL CONFIGURATION 182
LATERAL CONFIGURATION 26

This one is a little sluggish in roll. This is just like an A-4, the airspeed dives on that side if you pull power back. The power is the biggest judgement I had to make before, but the roll is very sluggish and the pitch is loose. It's manageable, but it's looser than the previous configuration (longitudinal configuration 182, lateral configuration 26). I'm having that same little problem with power right at the end there. I get going real fast, then I pull it off. If I don't watch it the airplane decays very fast in airspeed. This thing sinks like a rock. Between 135 and 125 knots, it's day and night in your ability to keep the nose up. If I drop to 125, I can't get it back hardly.

STEM 20
PILOT A
LONGITUDINAL CONFIGURATION 183
LATERAL CONFIGURATION 27

That was lousy. I got a little bit high and a little bit fast. I just couldn't get myself corrected down in time. I almost had it right. I got lined up laterally nice and early and then longitudinally I just couldn't quite get things settled down in time. It was close. I ended up landing a little long. That was a good landing. It was slightly long but the airplane seems to have a tendency that way of having trouble settling down longitudinally. I never really got on centerline that time. I was really worried about speed control, so I got my speed okay but I wasn't happy with my lineup. I'm having a little trouble longitudinally making things work out but it's not bad. I solved my problems laterally nice and early. Longitudinally I always had to feel for it a little bit. I had trouble settling down exactly. I had a tendency to land a little long.

STEM 20
PILOT F
LONGITUDINAL CONFIGURATION 183
LATERAL CONFIGURATION 27

This airplane has some roll sluggishness to it. The roll of the airplane is adequate, the pitch response is okay, the engine power seems to be very sensitive. In other words, before when I would pull it back nothing would happen. Now when I pull it back, it rolls back quickly. As far as pushing it up, same thing. I just haven't been pushing it up very much because it rolled up so fast last time.

STEM 20
PILOT A
LONGITUDINAL CONFIGURATION 184
LATERAL CONFIGURATION 28

This one is going to be hard to land. Sort of sluggish in roll and seems to couple in pitch a little bit. It is very difficult to make the lateral corrections getting close in. I just end up landing with bank on because I can't get the directions sorted out, so I end up still correcting touchdowns. I have to try to get lined up and settled down earlier to compensate for the sluggishness of the roll response. Touchdown heading is something you should be recording as a parameter. This one is sluggish laterally. Very heavy and very difficult to make a quick, accurate, directional change or bank angle change. So much so that that's taking almost all my time and I hardly have any time left to do a longitudinal fix. I'm fighting the roll right down through to touchdown. I just don't have time to settle down my longitudinal problems.

STEM 20
PILOT F
LONGITUDINAL CONFIGURATION 184
LATERAL CONFIGURATION 28

That one felt about like the other ones.

STEM 20
PILOT A
LONGITUDINAL CONFIGURATION 185
LATERAL CONFIGURATION 29

One thing to remember through all of these things is the artificiality of the sight picture in here. You're still missing the majority of the cues that you get in the real world. Sometimes I think everything is going to be right and I think I have it set up, and I pick up visually too late that something is slightly not right or I'm a little bit low and I couldn't tell until I got too close to the ground. So that lends an error of unreality to it just because of the cartoonishness of the visuals. It's not bad, but it definitely has an affect. I'm finding a longitudinal PIO tendency here. You are almost better to take all of these as data and just giving maybe 10 of each or something. Then you could just draw a centroid of where I managed to get it on every time. But sometimes I just goon it up while I'm experimenting, so you'd have to get a bigger data base. I guess it's a good way to do it for me to tell you which ones were representative best effort runs and you could compare those. But another equally valid way to do it of course would be just to do enough of these that you get a statistical sample for how good one is versus the other. As a description of these set of flight controls, I find there is a tendency to have to hurry. I'm ending up lined up off a little bit, and I have to just about work to the limit of my ability to get a good left/right line up. But I can generally get it in time to solve my longitudinal problem as well. The sequence of events are I'm working hard enough to solve my lateral or my center line problem that I tend to lose my airspeed a little bit. I either get too fast or too slow, but then I get close to center line, I can now divert my attention to solving my airspeed problem and my longitudinal touchdown point problem. So I can meet the desired objectives that I want at fairly high workload. If we had tasks, I'd predict this would be an equivalent of about a CHR 4 in that I'm putting in a fairly heavy work load but I'm getting what I'm starting to see as our typical desired type of performance criteria. Also if you were building a Cooper-Harper performance description for this you would have to specify how many landings you could beat those criteria on. Desired would be that you could make your desired criteria 90% of the time and adequate would be on the runway all the time.

STEM 20
PILOT F
LONGITUDINAL CONFIGURATION 185
LATERAL CONFIGURATION 29

I can tell this one has some real sluggishness already. I'm getting the airplane in position early. I'm just landing in front of the touch downs every time by about 150 - 200 ft. So I guess this roll configuration seems a little more sloppy than the previous two (lateral configurations 31 and 30). Maybe a little bit sloppy in pitch. Other than that I don't have that many comments on it.

STEM 20
PILOT A
LONGITUDINAL CONFIGURATION 186
LATERAL CONFIGURATION 30

I'm having a little more sluggish thrust response here. The noise comes right up, but I had trouble getting my airspeed exactly when I wanted it. The airplane flies pretty well. I seem to be struggling with speed. I'm all over the place with the throttle. The airplane is doing what I wanted it to do. It's giving me nice corrections, it's letting me line up, I'm just struggling with speed control. You could probably look at the data and see the number of throttle movements and the magnitude of them. This airplane seems to fly alright. The problem seems to be in thrust response. It takes a long time to get my airspeed correction in. I really can't put in throttles and then see an immediate response out of the airspeed indicator. It's like an A-7 or something. So I need to anticipate correction a lot and it's hard to do when you are constantly changing your conditions. My impression is that the airplane flies okay and I'm dealing with a sluggish thrust response that's making airspeed control difficult. I could make adjustments longitudinally and laterally in the short strokes and still get it solved. Often I was paying so much attention to airspeed that I was messing up the other two because I didn't have time to pay attention to them. Once I got airspeed nailed the airplane was pretty easy to put where I want.

STEM 20
PILOT F
LONGITUDINAL CONFIGURATION 186
LATERAL CONFIGURATION 30

Way short and way slow. I landed about 500 ft. short of the zone. The problem was that the sluggish roll when I was trying to correct back I think put me into a sink rate. So there was a little bit of a sluggish roll and my problem of not leading it. I'm getting too low too early. I think it's pilot technique, although the roll being sluggish doesn't help much. One problem here right now is that you sort of have to guess where your power is at the start of this thing because the throttles are wherever you left them from the last run. And at this kind of situation, that can have a big impact on how you enter into the maneuver. So I'm just going to start setting the throttles before going to operate. I did notice a big difference in that one. The roll seems a little sloppy on the roll out. In other words, if you use an aggressive bank to start, I'm finding the length of time to roll back is causing a loss of altitude and then a consequent over correction on my part trying to get it back on the concrete. So there is a little bit of a sluggish roll.

STEM 20
PILOT A
LONGITUDINAL CONFIGURATION 187
LATERAL CONFIGURATION 31

This is a good flying combination here. My very first try, I hoisted it around a little bit over aggressively and still got very close to the parameters I've been seeking all along. Good flying airplane. I like the way that airplane handles. It's good directionally. It lets me solve the problems. Longitudinally the response seemed fine, and the thrust response

seemed fine. When I did mess it up it's just because I blew one of my initial line up parameters then I realized I was either too low or I was too far left or something, and then I'm just forcing myself into a too high gain of task. That's just the result of not looking outside carefully enough or looking at my altitude careful enough. It's not really a flight control dynamics problem. I think that airplane is a good handling airplane for this mission task.

STEM 20
PILOT F
LONGITUDINAL CONFIGURATION 187
LATERAL CONFIGURATION 31

I'm landing well short of the touchdown point. I'm still trying to figure out how exactly this visual presentation works out here on this landing. That configuration seems to me to be awfully, awfully hot. In other words, I am constantly back on the power just to keep the airspeed down. But other than that I had no problem with the controls. They basically put the airplane where I wanted it to be. I don't really have any comments. Nice roll rate when I commanded it. Nice pitch rate when I commanded it.



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